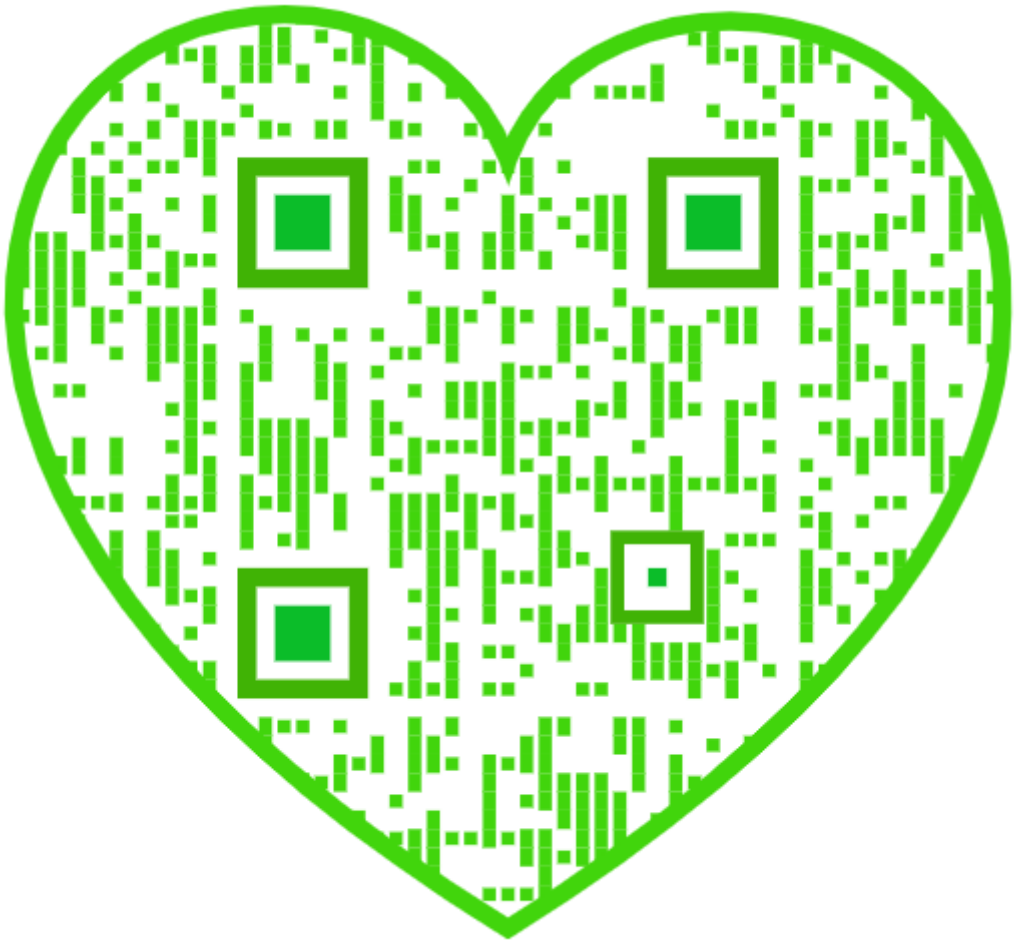

STUDIES IN
THE ANATOMY AND SURGERY OF THE NOSE AND EAR

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BY

ADAM E. SMITH, M. D.

Past Chief Medical and Sanitary Officer, Nile Reservoir Works, Assuan, Egypt;
Past Instructor in Operative Surgery, Columbia University Medical College;
Past Attending Surgeon, German Hospital, O. P. D., New York City

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DEDICATED, IN LOVING MEMORY,
TO MY FRIEND AND TEACHER

DR. FRANK HARTLEY,
OF NEW YORK,

AN ARTIST OF THE HIGHEST ORDER IN HIS CHOSEN SPECIALTY AND A SOURCE OF CONSTANT INSPIRATION TO HIS PUPILS AND COWORKERS

PREFACE

This little volume deals with the anatomy of the nose and ear from a surgical standpoint. The illustrations were made directly from dissections prepared by the author and drawn with great accuracy under my supervision by Mr. Martin Peterson of the Anatomical Department, Columbia University Medical School. None of the drawings are schematic but represent anatomy from a practical standpoint, showing the relation of parts to their natural surroundings and to the head as a whole. Owing to their accuracy, and their instructiveness and scientific interest they should have permanent worth, and this is the main reason for presenting the studies in book form.

There are practical points in treatment which are new and novel based on natural physical laws and common sense, the value of posture in the treatment of otitis media and mastoiditis being one of particular interest. The mechanics of treatment by suction, in frontal sinus and maxillary antrum disease, is another.

I owe my original interest and appreciation of the subjects dealt with herein to Professors Krause and Katz of the University of Berlin, with whom I worked from 1895 to 1897. My interest was renewed and stimulated during my instructorship in the Operative Surgery Course, College of Physicians and Surgeons, New York (1900-1912), while working with Professor Frank Hartley, and it is due to his constant encouragement that the contents of this volume resulted.

I desire to express my gratitude to Professor H. T. Brooks for his ever-ready and painstaking assistance in reviewing the text, and to my wife whose constant and untiring aid in taking dictation for manuscripts and reading proofs was a great source of helpfulness.

The publishers of the *American Journal of Medical Sciences*, the *Annals of Surgery*, the *Medical Record* and the *New York Medical Journal* have kindly permitted me to draw upon material which first appeared in their respective journals as original articles over a period of several years.

I am also indebted to my publisher and his assistants for the advice and assistance in bringing out the volume in its present form.

February, 1918 ADAM E. SMITH

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I

THE IMPORTANCE OF NASAL BREATHING

I

THE IMPORTANCE OF NASAL BREATHING

For several years past much attention has been given to the importance of the removal of superabundant adenoid tissue, which is looked upon as the causative factor for all ills which really are due to defective nasal breathing and without a conception of the true relation of the various factors involved. I will here dwell particularly on the great importance and marked influence of air pressure upon the internal structures of the nose during normal breathing and the serious consequences which result when nasal breathing is not persisted in.

A person breathing constantly through the nose has nostrils of sufficient size to accommodate a volume of air to expand the lungs to their full capacity. Vibrissæ are present to keep out the gross particles of dust. The nasal fossæ within show a sufficient height with a low floor corresponding to the properly flattened palate, and the lateral walls are pushed sufficiently far out to give roomy fossæ on either side of the septum. Where a deviation of the septum exists the lateral wall of the corresponding side is made to encroach upon the maxillary antrum of that side in order to admit the required volume of air, the parchmentlike bone of the lateral wall receding before this continuous pressure of air, thus contributing one of the various factors in the production of asymmetry in the sinuses. The current of air passing backward draws the warmed air from the sinuses and becomes moistened and purified (filtered) by passage over the ciliated epithelium of the nasal membrane. On expiration the air heated and moistened in the lungs passes out through the nose; part of it is forced into the sinuses as a reserve for the next inspired air, which should be warmed and moistened before entering the lungs. Hence, the sinuses are the reserve chambers to warm the respired air, besides helping to reduce the weight of the skull and giving resonance to the voice. The openings to these sinuses are placed high up in protected places ideally situated to prevent extraneous matter from entering them and thus preventing their infection. The lining membrane which contains the blood supply for their bony walls gives off only sufficient moisture to preserve this structure.

The volume of air passing through the nasal fossæ from infancy onward exerts marked pressure on all the structures within the nose, pushing the

lateral walls outward and the floor downward sufficiently to give the space required for the growing capacity of the lungs. The low floor corresponds to the properly flattened roof of the mouth, the wide alveolar process allowing the teeth to develop without crowding. The air normally conducted through the nose and nasopharynx will produce sufficient pressure to support the vessels in the adenoid tissue normally present in the nasopharynx and hence keeps its growth within bounds. The nasopharynx is commodious, gives the palate a wider range of motion, and adds to its mobility,—a factor in proper enunciation.

To overcome the resistance offered by the comparatively small entrance which the anterior nares present for the large quantity of air to fill the lungs, the muscles of respiration are brought into play for the uniform expansion of the entire chest and lungs. A great quantity of blood is thereby drawn into the chest which bathes the lung tissue, thereby tending to preserve its healthfulness and also to increase the exchange of gases, and hence establish better metabolism throughout the body.

Against all this let us compare mouth breathing. The neglected nostrils are collapsed from disuse. The absence of air pressure within the nose has permitted the fossæ to remain narrow. If they are sufficiently roomy the mucous membrane covering the turbinals is swollen from nonsupport. From the same lack of pressure the floor of the nose has not been depressed, resulting in the high vaulted palate, the contracted alveolar process, and irregularity in the position of the teeth. The upper jaw and lip are pushed forward and the lower lip droops and is thickened.

At this point I desire to take exception to the accepted theory of Lombroso that the vaulted palate is a distinctive mark of degeneracy and substitute the above explanation as the true cause of that deformity.

In those in whom there is an abundance of adenoid tissue lining the nasopharyngeal wall, the vessels of this tissue being unsupported are continually in a congested state. Added to this is the negative pressure or suction resulting from the air sweeping through the mouth down the pharynx, constituting a second factor in the production of hyperemia of the adenoid tissue, both factors resulting in the true cause for the superabundant growth of that tissue. The adenoid tissue which occludes the postnasal space interferes with the proper aëration of the middle ear through the Eustachian tube, producing defective hearing, and interferes with the proper function of the soft palate which so often is manifest in young children and frequently is the only cause for their defective speech. With the disturbed circulation in

the nose and nasopharynx the circulation at the base of the brain is affected, influencing the mentality of the mouth breather, who frequently is put down as a dullard at school.

The dust laden and infected air passes through the mouth, producing dryness, infecting and inflaming the tonsils and pharynx, eventually, permanently enlarging the tonsils through repeated insult and increasing the liability to circumtonsillar infections. On account of the large opening which the mouth presents, no extra effort is required during inspiration, as is the case when the resistance of the smaller aperture of the anterior nares must be overcome; hence the muscles of the chest are not brought into play as in the former instance, the chest remains contracted, and the lungs incompletely expanded and aërated especially in the apices. The increased amount of blood which should normally enter the chest does not enter, leaving the lungs in an anemic condition oftentimes unable to cope with the germs which enter with the dust laden air. The air passing into the lungs is cold, unfiltered and unmoistened, chilling the lung, affecting its lining membrane and circulation. The deposit of dust which might contain noxious germs in great numbers and too numerous to be taken care of by a reduced circulation, frequently results in inflammation and tuberculosis of the lungs.

At night the mouth breather is restless and suffers with disturbed sleep. His head is thrown back, due to the relaxation and shortening of the lower jaw muscles and the tension of the extensors at the nape of the neck. For this reason the mouth remains open in spite of cloth or leather jaw supports which are frequently used to overcome mouth breathing at night. Besides the increased drag on the lower jaw, there is also added the disturbed circulation of the head due to its retroflexed condition.

Mouth breathing is due to several causes, but in most instances it is purely a habit. In the case of a nasal obstruction the amount of air possible to be drawn through the nose may be entirely inadequate, and mouth breathing becomes a necessity until the obstruction is removed. In other cases it occurs in constitutions in which the muscle tonus has been lowered in various parts of the body, resulting in relaxed and flabby muscles and ligaments. When this occurs in muscles supporting the lower jaw (the temporals, masseters, and pterygoids), the jaw drops and mouth breathing occurs and becomes a habit. The relaxed lower jaw muscles remain shortened, the reduced traction on the bone itself producing the small mandible and receding chin. The drawn skin of the cheeks, produced by the dropping of the jaw, presses on the superior alveolar process, and this, added to the vaulted palate, is a second

factor, producing the contracted alveolar process and irregularity of the teeth.

Hence, the immense importance of unrelaxed effort on the part of physician, and especially parents, to induce children from infancy up to keep the mouth closed and make every effort to breathe through the nose, even if obstruction exists in the form of temporary swelling of the nasal membrane or permanent obstruction.

Breathe through the nose, and the air pressure will prevent the excessive growth of adenoid tissue. Remove adenoid growths if they form an obstruction, but if nasal breathing is not persisted in after their removal the excess of adenoid growth will again take place.

Besides repeated remonstrance on the part of physician, teacher, and parents, or others in the home, nasal breathing can be enforced during sleep by closing the lips by means of skin plaster.* When this is done sleep is more peaceful and the head rests in its normal position. The child accustomed to the sensation of nasal breathing at night can be so much more readily prevailed upon to persist in nasal breathing throughout the day. So, also, much of the harm done by neglect during the waking hours can be mitigated by the normal breathing during sleep.

Not only can all the ill effects of mouth breathing be prevented, but after they have existed a number of years they can be corrected by the changed mode of breathing, i. e., normal nasal breathing. The oftentimes hideous physiognomy of the former can be remodeled and changed into a normal, sometimes even a handsome type, if the error is corrected before the firmer bones have hardened to too great a degree.

*Gold Beaters Skin Court-plaster.

II

SOME SUGGESTIONS ON THE TREATMENT OF INTRANASAL CONDITIONS

II

SOME SUGGESTIONS ON THE TREATMENT OF INTRANASAL CONDITIONS

In acute and chronic rhinitis and nasopharyngitis more or less frequent cleansing of the nasal cavity is accepted as a proper procedure. Heretofore this has been carried out by the patient by the use of sprays or douching or sniffing of salt water or of solutions with combinations of drugs, such as sodium chlorid and bicarbonate with boric acid; or as found in the various detergent solutions usually containing thymol, eucalyptol, sodium chlorid, bicarbonate, and biborate, with or without glycerin and alcohol. With a dry condition of the membranes, solutions containing glycerin seem to be contra-indicated and solutions free from glycerin and alcohol are advisable.

When using the nasal douche, the patient should be instructed to hold his head sideways, over a basin, instead of backwards, and to apply the douche to one nostril and permit the fluid to pass through and run out of the other nostril. The mouth should be kept open in order to fix the soft palate and allow breathing to go on through this passage. The patient is cautioned not to swallow, which would relax the palate and cause the fluid to enter the pharynx or larynx and produce a paroxysm of cough. After clearing the nose the douche is refilled and applied to the other nostril; the fluid then flows in the opposite direction. This is less harmful than the use of an atomizer, as it does not so much injure the epithelial lining. For several years I have considered it essential in all *acute* inflammatory conditions of the nose to make topical applications by means of a cotton applicator, and to avoid spraying or irrigating, for fear of conveying infectious material to the sinuses or middle ear or both. For the same reason, patients have been instructed in the use of the cotton applicator and warned against the dangers of douching or spraying to which so many sinusitides and otitides are due. A 25 per cent. solution of argyrol, with equal parts of glycerin in water, has been the disinfectant most favored. This is repeated every twenty-four to forty-eight hours, according to the acuteness and severity of the inflammation. Spraying is never resorted to without being immediately followed by suction treatment.

Far superior to any spraying or douching of the nose or the nasopharynx, especially for prolonged use, is the cleansing of the nose from behind forward. This might be called nasopharyngeal gargling and is performed

as follows: After brushing the teeth and rinsing the mouth, the throat is gargled to free it from food particles and mucus, which would be liable to be projected into the nose. After taking a long breath, a mouthful of the cleansing solution chosen is taken, the head is thrown back, as with ordinary gargling, but instead of fixing the palate and projecting the air through the mouth, as in ordinary gargling, the palate is relaxed and the air is blown through the nose with the same gurgling force. The fluid thus mounts higher and higher into the nose until it is discharged from the anterior nares. The head is now thrown forward over the basin to allow the fluid to flow out. This procedure is repeated three or five times until the nose is thoroughly cleared and open. Spraying the nasopharyngeal space is usually most unsatisfactory on account of the uncontrollability of the soft palate, the constriction of the nasopharyngeal space, due to the spasmodic contraction of the muscles of that region, and the possibility of trauma from upward projecting nozzles necessary for the purpose. On the other hand, the nasopharyngeal gargling just described is as harmless to all the tissues as douching and far more effective, because it reaches all the crevices and, on account of the natural slant of the turbinals, the fluid, passing from behind forward, cleanses both the inferior and superior surfaces of these bodies and flushes the meatuses as well as the septum. Besides this there is no injury to the tissues, as with the projecting spray or nozzle of the atomizer. The nasopharynx and the posterior nares, which are the most important places for harboring disease germs and infectious material, are reached more effectively than is possible by any other method.

This procedure, so beneficial as a curative agent, is far more so as a prophylactic measure. From personal experience it has been determined that with its daily application as a part of the morning toilet, severe inflammatory processes which previously thereto had been of most frequent occurrence, have been prevented and aborted over a long period of months. The procedure requires some experience and skill before it can be acquired, but if each step of the instructions is faithfully carried out and persisted in, success eventually will come and the benefits thereby derived will many times repay the effort used in acquiring it.

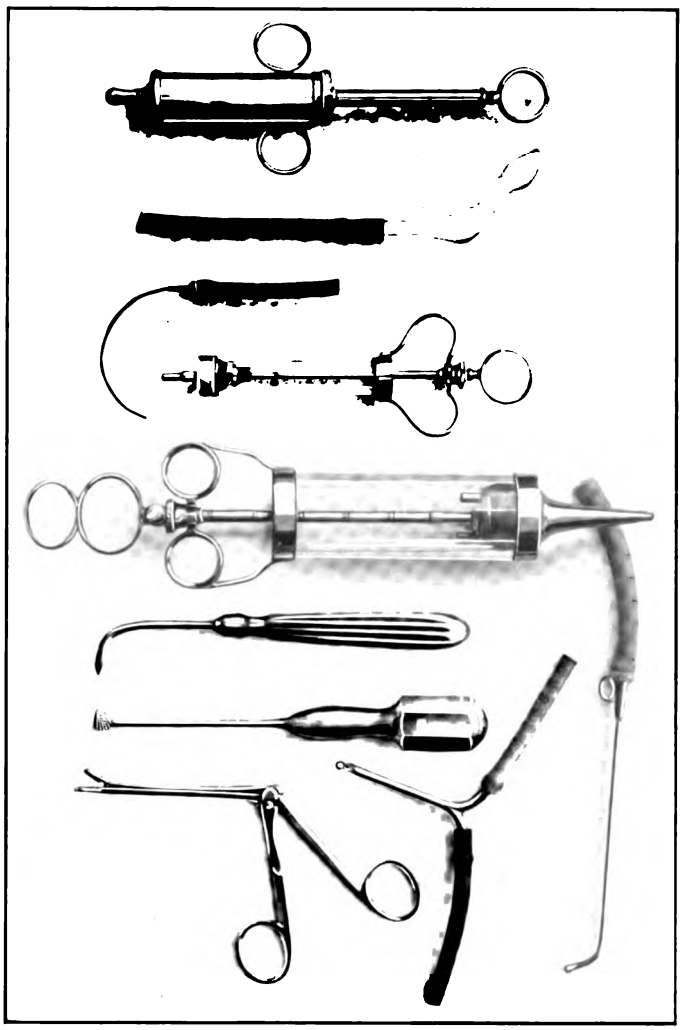
The objection may be raised that with a forcible projection of fluid into the nasopharynx the solution might enter the relaxed orifices of the Eustachian tubes and cause middle-ear infection. If any fluid should enter the tube a very simple procedure will withdraw it. This consists in compressing the nostrils with thumb and forefinger of one hand and at the

same time swallowing a glass of water without taking a breath. This will produce sufficient suction to withdraw the fluid and thus clear the tubes. This is the method I have used for several years in all otitis-media cases, having it repeated frequently during the day for clearing the tubes of secretions and causing an exchange of air in the middle ear. A milder degree of suction can be effected by compressing the nostrils and carrying out a swallowing movement, without the use of a fluid.

In cases of severe rhinitis due to ordinary infection or more particularly to influenza, extension to the sinuses often occurs. The ostia of the sinuses are so situated, that for ordinary purposes they are in the most protected places to prevent entrance of extraneous matter; but if infection enters and a secretion in the form of serum or pus is present, the ostia are placed most disadvantageously for proper drainage. Nevertheless, in carrying out conservative treatment it is possible, by resorting to the posture of the head, to have the ostia placed at a most dependent point, and then by means of suction, or irrigation and medication combined with suction, to defer operative procedure or to render such unnecessary.

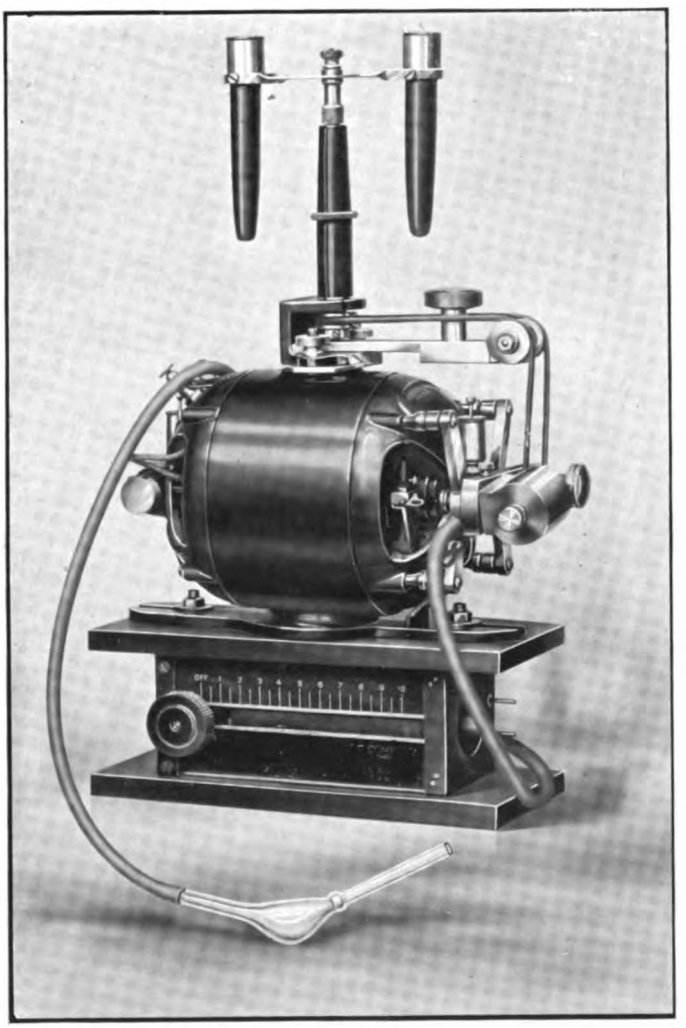
In inflammations of the nose that have extended through the hiatus semilunaris into the nasofrontal duct or into the ostium of the maxillary antrum or through the ostium of the sphenoidal sinus, I have found the following procedure most effective: The nasal membrane receives an application of one of the penetrating non-irritating silver preparations. It is then sprayed or douched with a detergent solution, as would be done ordinarily for disinfection and treatment of acute or chronically inflamed membranes. In the case of frontal sinusitis, cocain is then applied to the region of the nasofrontal duct, particularly on account of its non-irritating, astringent effect. Thereafter suction is carried out by means of a glass nozzle and suction pump, the former connected with the latter by a small piece of rubber tubing, thereby minimizing the shock when the piston is brought down. The glass nozzle has an ampulla below which catches the secretions and prevents them from entering the pump. The amount of suction is regulated by compressing the nostril of the other side, the inrush of air counteracting the suction as well as sweeping the secretions from the nostrils into the glass nozzle. The glass nozzle completely clogs the nostril into which it is inserted and the pressure of the finger against the other nostril occludes both openings, preventing access of air from this source, otherwise no negative pressure would result. The patient is instructed to take a few deep inspirations and after expelling the air to keep his lips tightly closed. The suction pump

PLATE I



Suction pump, glass nozzle, probe cannula, irrigating syringes, trocar for maxillary antrum, fraise, punch forceps, cannulæ for trocar opening.

PLATE II

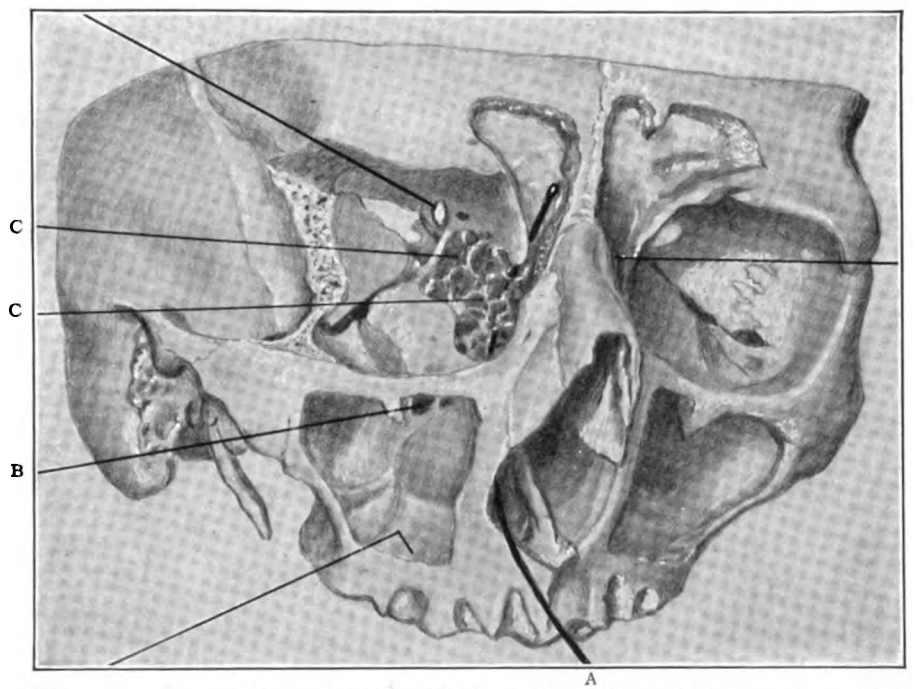


Electric pump with special glass nozzle for suction treatment of nose and ear.

is now put into action and continued until the patient shows distress in the region of the sinuses or is again compelled to take breath. The interval permits cleansing of the nozzle which by this time has received some of the secretion from the nose or even from the sinus. The accompanying illustration (Plate II) shows a more recent greatly improved nozzle, the front tubing of which is flattened and can be introduced into the depth of the nose, thereby avoiding the soft parts near the orifice which clog the tip of the ordinary glass nasal nozzle. For office use I have entirely replaced the hand pumps by the more efficient electric suction pump, which does away with the physical exertion on part of the surgeon which the hand pumps entailed. The suction is to be repeated from four to six times on the affected side, or on both sides if both sinuses are involved. The treatment is repeated every second or third day according to the acuteness of the condition. Relief usually is immediate and lasts for many hours, each subsequent treatment prolonging the time the patient is free from pain. We thus effect not only withdrawal of retained secretions and an exchange of air in the sinuses, but also a temporary hyperemia which is most effective in all inflammatory processes. At first only mucus from the nose or mucus, mucopus, or pure pus from the sinus itself may appear in the ampulla of the glass nasal nozzle. If pure pus appears at the first and the second treatment, this is rapidly changed on subsequent treatments to mucopus or pure mucus with a corresponding relief of pain or discomfort over and within the sinus. The patient is instructed repeatedly to use suction at home by means of compressing the nostrils and swallowing with or without fluids. This, with internal medication in the form of salicylates, purging, drinking of alkaline waters, douching or gargling the nose, and the application of heat or cold to the affected sinus will effect a rapid cure. The patient is also instructed to expose the face to the direct rays of the sun for several hours daily.

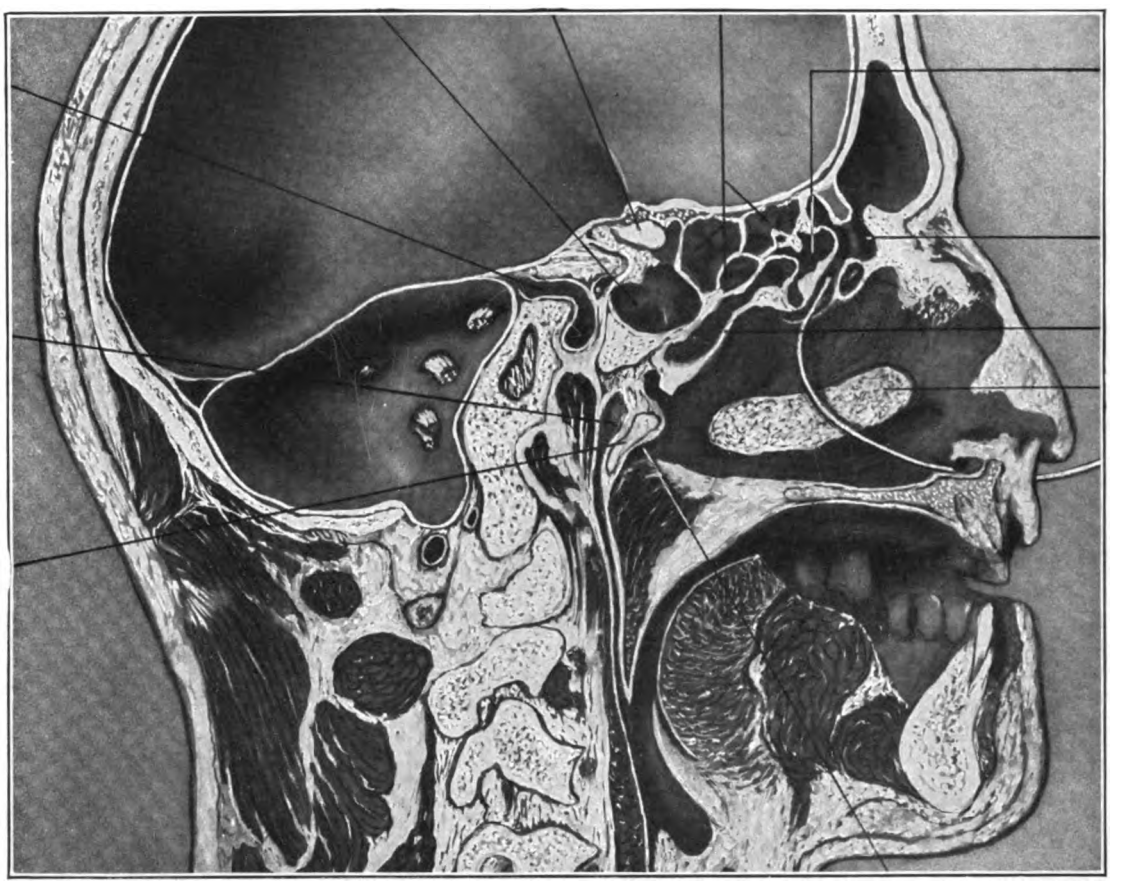
In the treatment of inflammation of the maxillary antrum a similar procedure is carried out, and here the location of the opening of the sinus, being situated at the upper inner angle of the sinus and requiring a dependent position of the head if drainage through the ostium is to be effected, is taken into consideration. During suction the patient must lie on his side with the head as low as is consistent with comfort, the affected side being uppermost, the maneuvers with the suction pump and nozzle being the same as described for the frontal sinus. The posture for effective suction treatment with sphenoidal sinusitis should be with the head forward and low down, the ostium being situated well up on its anterior wall. If suction and cleansing and

PLATE III



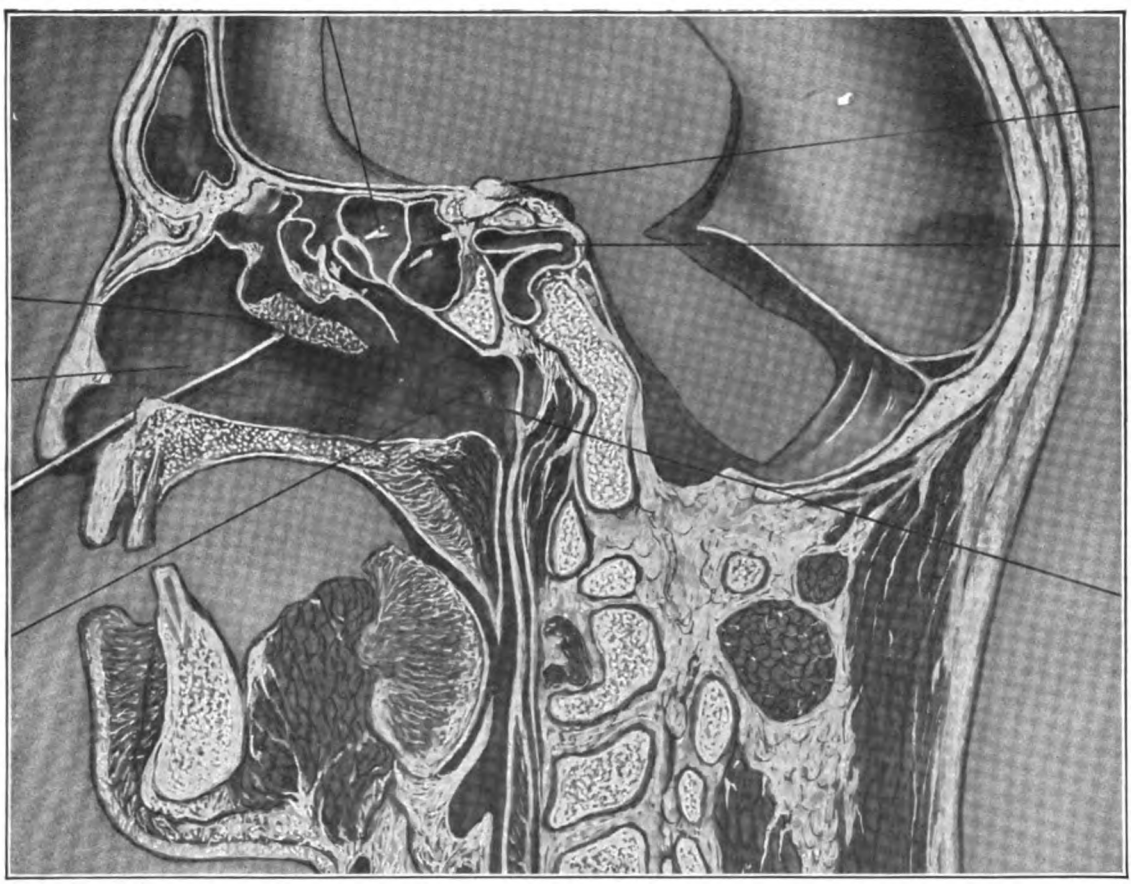
A, Probe cannula passed through infundibulum and nasofrontal duct into frontal sinus. B, Ostium of maxillary antrum is seen at upper inner angle of sinus. C, C, Ethmoidal cells are seen with orbital wall removed.

PLATE IV



Middle turbinal removed to show probe cannula (A) passing through hiatus semilunaris and infundibulum. The frontal sinus communicates with the nose indirectly through the ethmoidal cells. Removal of ethmoidal cells would be necessary to penetrate into the sinus with a cannula.

PLATE V



Probe cannula (A) introduced at an angle of 45° with the floor of the nose into the ostium of the sphenoidal sinus. Section represents middle turbinal, ethmoid and sphenoid cells and septum lifted from previous specimen.

internal medication do not suffice for clearing the condition, irrigation combined with other treatment becomes necessary.

In frontal sinusitis a probe cannula with a diameter of eight centimeters and bent in the form of a semicircle is introduced, with the aid of the nasal speculum and good illumination, into the middle meatus, through the hiatus semilunaris upward and forward along the infundibulum and nasofrontal duct into the frontal sinus. The end of the instrument will be free in the sinus and permit thorough irrigation and medication of the part. The cannula should be of the smallest size and of good length, and it is well first to bend the tip to conform to the side of the affected sinus. Usually the anterior part of the middle turbinal forms a fold or curtain or bridge where it is attached to the lateral wall of the nose. It is behind this fold that the cannula must pass into the nasofrontal duct. Sometimes the hiatus semilunaris can be seen for a good distance upward, and the cannula can be introduced at its upper part instead of traversing the entire length of the infundibulum. The medicating and irrigating fluids are now introduced through the cannula to which a small piece of rubber tubing is attached. This serves for the easy application of the syringe, the patient steadying the cannula with two fingers while the irrigating and medicating fluids are being introduced. This is immediately followed by suction heretofore described. If introduction through the natural passage is impossible, it is sometimes necessary to remove the anterior part of the middle turbinal, especially the part forming the bridge above mentioned and also the air cells contiguous to the nasofrontal duct.

In the case of the maxillary antrum the probe cannula has its tip bent at right angles for a distance of half an inch. This is introduced through the middle meatus and hiatus semilunaris to the lowest or posterior end of the infundibulum to pass through the ostium into the antrum itself. Medication and irrigation are carried out in the same manner as in frontal sinusitis, with the patient in the erect posture, and suction is carried out in the recumbent posture with the patient on his side and the head low down.

If a decayed tooth projecting into the antrum is the cause of the sinusitis, it will be necessary to remove the offending root; but it is preferable to make the intranasal opening for treatment and drainage instead of a large opening through the socket. It is true that in the latter instance a more dependent point in the antrum can be reached, but reinfection from the mouth prolongs the process. If on the other hand the opening through the socket is plugged between treatments to prevent infection, retention of the secretions has the

same disadvantage as in the case of constant drainage but reinfection from the mouth.

With involvement of the sphenoidal sinus, a cannula with the tip slightly bent is passed upward and backward, at an angle of 45 degrees with the floor of the nose through the ostium into the sinus itself. The ostium is at times located a little distance out from the septum. This is medicated and irrigated as in the case of the other sinuses but should be followed by air pressure with the head bent forward and low down and suction carried out in the same posture.

If introduction of the cannula into the frontal sinus is unsuccessful owing to the fact that the nasofrontal duct does not directly communicate with the meatus but opens into an ethmoidal cell, a passage is made by removing the upper and anterior portion of the middle turbinal and contiguous ethmoidal cells, until a sufficiently large opening is made to introduce a cannula and to give sufficient drainage.

When the ostium of the maxillary antrum is inaccessible for irrigation or insufficiently open for proper drainage, an artificial opening is made about half way back through the lateral wall of the nose as close to the floor as possible. A trocar one half centimeter in thickness, with the tip three and a half centimeters long bent at right angles to the shaft, is used for the purpose. In the middle of the lateral wall the mucous membrane and the parchmentlike bone can be pierced readily. The part is cocainized, the instrument is introduced perpendicularly, and then so turned that the point impinges on the lateral wall. Pressure is now made outward and as the handle is moved upward and downward a good-sized opening is effected with the least degree of pain. Through this opening the cannula is now introduced and treatment is given as before described. Medication and irrigation are repeated for a number of sittings, the cavity draining between times; or the patient is instructed to resort to irrigations at home, introducing the cannula himself.

If the opening cannot be kept patent sufficiently long to effect a cure —as it usually heals up within two weeks—more of the wall can be removed by means of a forceps or with an instrument having the same curve as the trocar, but with a fraiselike end, which with a similar movement will break up and carry away a greater amount of bone and produce a more permanent opening.

If the ostium of the sphenoidal sinus cannot be reached, a portion of the middle turbinal must be removed to make it accessible. If the ostium

is too small for the introduction of a cannula and for proper drainage, a portion of the entire anterior wall below the ostium must be removed with a drill, chisel, or bone-biting forceps.

Only when the various stages of this more conservative treatment have been found insufficient to effect a cure are more radical methods, with the exposure of the sinuses from without, permissible.

III

A CONTRIBUTION TO THE ANATOMY AND SURGERY OF THE NOSE AND ITS SINUSES

III

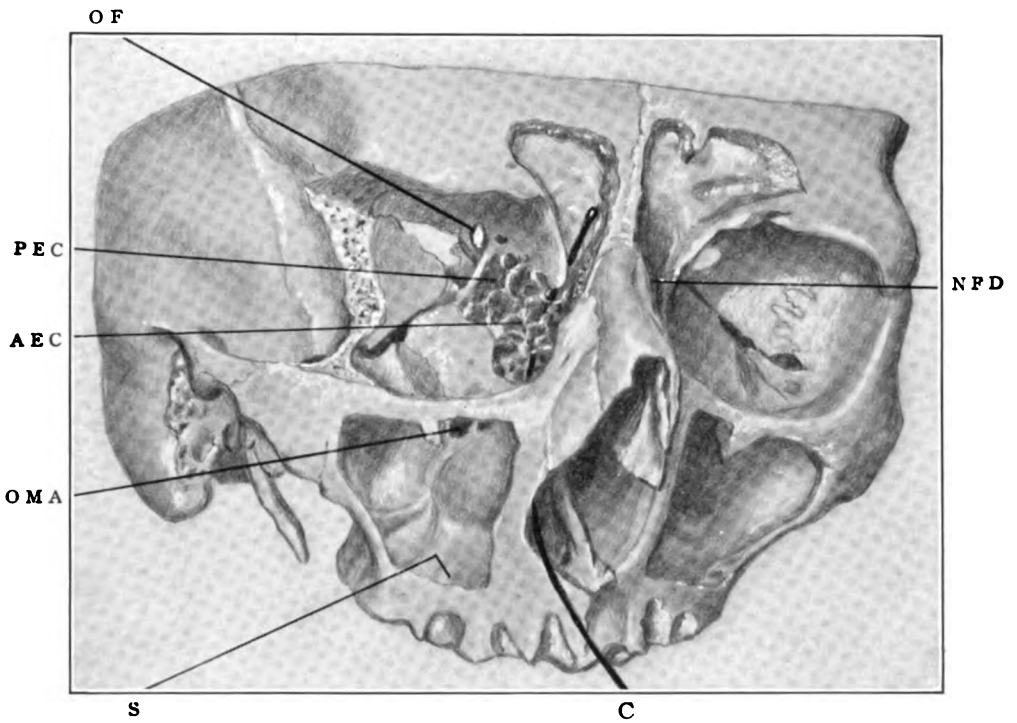
A CONTRIBUTION TO THE ANATOMY AND SURGERY OF THE NOSE AND ITS SINUSES

The specimens of skulls herein illustrated were obtained during the course of instruction on the cadaver at the College of Physicians and Surgeons and were prepared, after operative procedure on them, by the students, had demonstrated that they presented points of special interest.

The specimen of the sagittal section showing the occasional course of the infundibulum ending in ethmoidal cells, instead of in the nasofrontal duct, was of further interest on account of the single sphenoidal sinus. The series of vertical sections presents the average condition found in most human beings; so also the horizontal section, excepting that in this one a marked erosion of the left temporal bone was found but not commented upon in this treatise.

Plate VI represents a skull with well-formed symmetrical sinuses. The frontal sinuses are exposed and of medium size. The maxillary antra are well developed. A portion of the outer wall of the right orbit has been removed; on the inner wall the bone has been elevated from the anterior and posterior ethmoid cells, showing that the uppermost cells are on a line with the inner canthus of the eye. A cannula has been passed through the nasofrontal duct and projects into the right frontal sinus; the nasofrontal ducts are seen to be located about one centimeter from the median line of the face. Their upper ends also correspond to the inner canthus of the eye. The ostium of the right maxillary antrum shows at the upper part of the inner wall; a ridge of bone, in the middle of the upper wall, indicates the infraorbital canal. The floor of the antrum is lower than the floor of the nose and shows the prominences of sockets of the molar and bicuspid teeth. An opening through the last molar socket, therefore, corresponds to the most dependent point of the antrum. On the other hand, a trocar introduced low down and through the inferior meatus corresponds to a point at least one centimeter above the floor of the antrum. Nevertheless, draining an antrum from the floor into the mouth has great disadvantages, because of liability to reinfection from the mouth. If a plug is introduced to prevent reinfection, the secretions are retained and the advantages of drainage at the most dependent point are lost. With the intranasal opening and treatment described in Chapter II this disadvantage does not exist, but repeated cleansing is possible as in the former instance, and the opening can be made the most dependent point if the patient reclines or sits with the head far over to the opposite side.

PLATE VI



O F, Optic foramen.
P E C, Posterior ethmoid cells.
A E C, Anterior ethmoid cells.
O M A, Ostium of maxillary antrum.
N F D, Nasofrontal duct.
S, Prominences corresponding to sockets of bicuspid and molar teeth.
C, Cannula passed through infundibulum and nasofrontal duct into frontal sinus.

Plate VII demonstrates the asymmetry of the frontal sinuses, which is a very common condition. Perfect symmetry is a great rarity. In this instance a large sinus with the outlet into the left nares extends far over to the right with the small partial septum at the upper portion, in the middle line. On the right side is a frontal cell representing a greatly diminished right frontal sinus. Ethmoid cells and sphenoidal sinuses are partially exposed. Here the surgeon would be able to introduce the probe only a very short distance into the sinus of the right side, as described in Chapter II. On the other hand, if exposure of the sinus had been made at or above the supraorbital arch, only the sinus of the left side would have been reached and that of the right, probably, missed.

PLATE VII

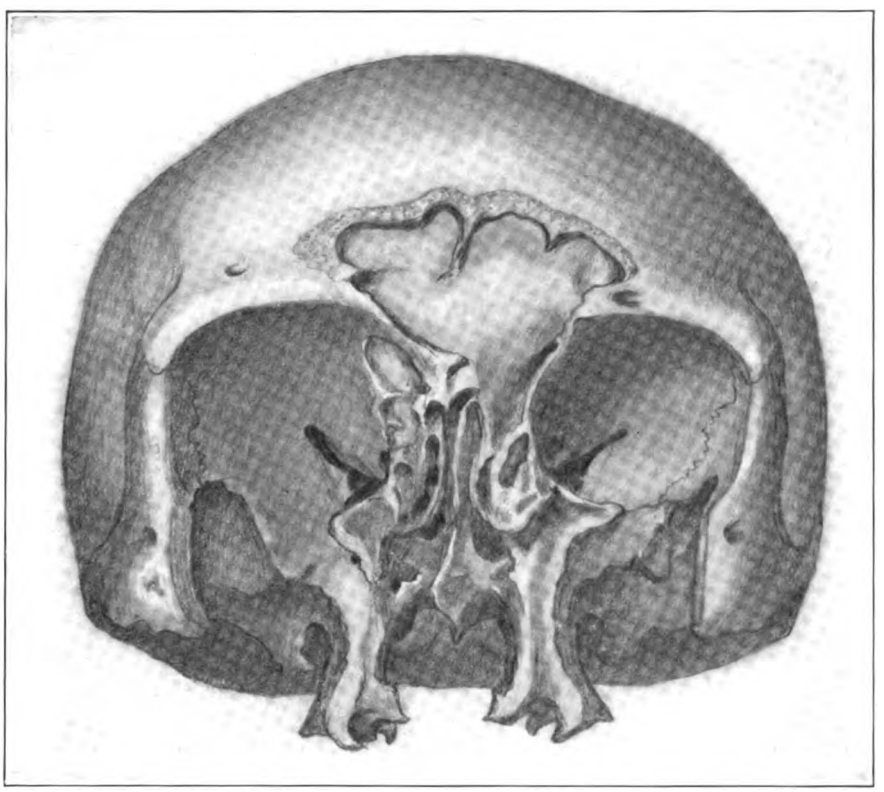


Plate VIII shows a specimen with all the sinuses exposed. This typifies a frequent finding of asymmetry which is found also in the rest of the head, the cross sections frequently showing that one part of the middle or inner ear is one to two centimeters farther forward or backward on the other side. This same rule holds good for the trunk and the extremities. It may be stated as a corollary in human anatomy that asymmetry is the rule, and that perfect symmetry the exception. The sinus with an opening into the right nares is of medium size but extends to the left of the median line of the face to practically correspond to the sinuses of both sides. The sinus with the opening into the left nares represents only a frontal cell. As if to counterbalance the enlarged frontal sinus on the right side, nature provided a correspondingly large sphenoidal sinus on the left side. The septum separating the smaller right from the larger left sphenoidal sinus has an important bearing on the exposure of the pituitary gland, which is lodged in the sella turcica. The prominence on the posterior wall of the sphenoidal sinus represents the corresponding depression of the sella, but in order to expose the gland, this prominence, irrespective of the direction or deflection of the sphenoidal septum, should be opened in the median line of the skull. This specimen also shows asymmetry of the maxillary antra, the one on the right side being larger than that on the left.

PLATE VIII

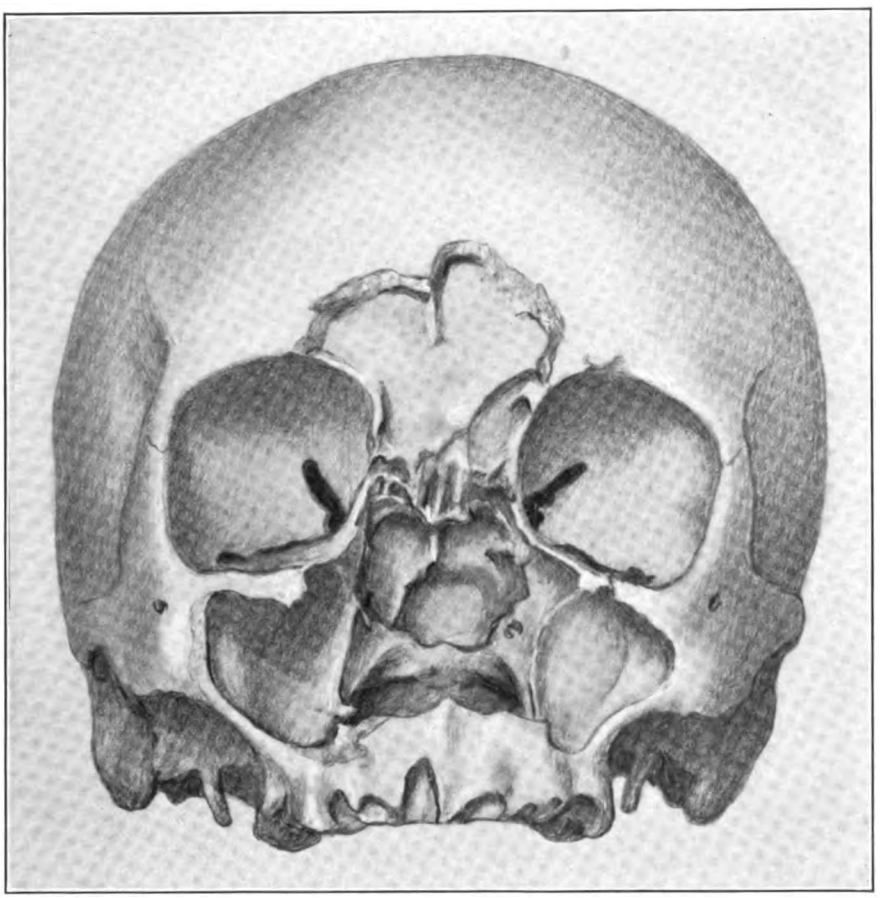


Plate IX shows the skull of a syphilitic subject showing small frontal sinuses. This demonstrates the importance of beginning the incision for exposure of the sinus low down at the inner canthus of the eye. On this anatomical subject the student had made an incision horizontally through the eyebrow, and, before exposing the sinus, had penetrated into the cranial cavity. On the left side a similar incision was made, and before the student realized he had entered a shallow sinus, he penetrated the posterior wall and entered the cranial cavity a second time. This might have been avoided in both instances by first exposing the nasofrontal duct low down and probing the sinus to determine its size and location. There was complete syphilitic erosion of the interior of the nose including the septum, both lateral walls with their turbinals, and even the outer wall of the right antrum. The ethmoidal cells and sphenoidal sinuses were deprived of their inferior walls and the erosion extended into the basilar process of the occipital bone. The hard palate was affected similarly. This syphilitic erosion was so complete that the most thorough surgical procedure would not have surpassed it in extensiveness.

PLATE IX

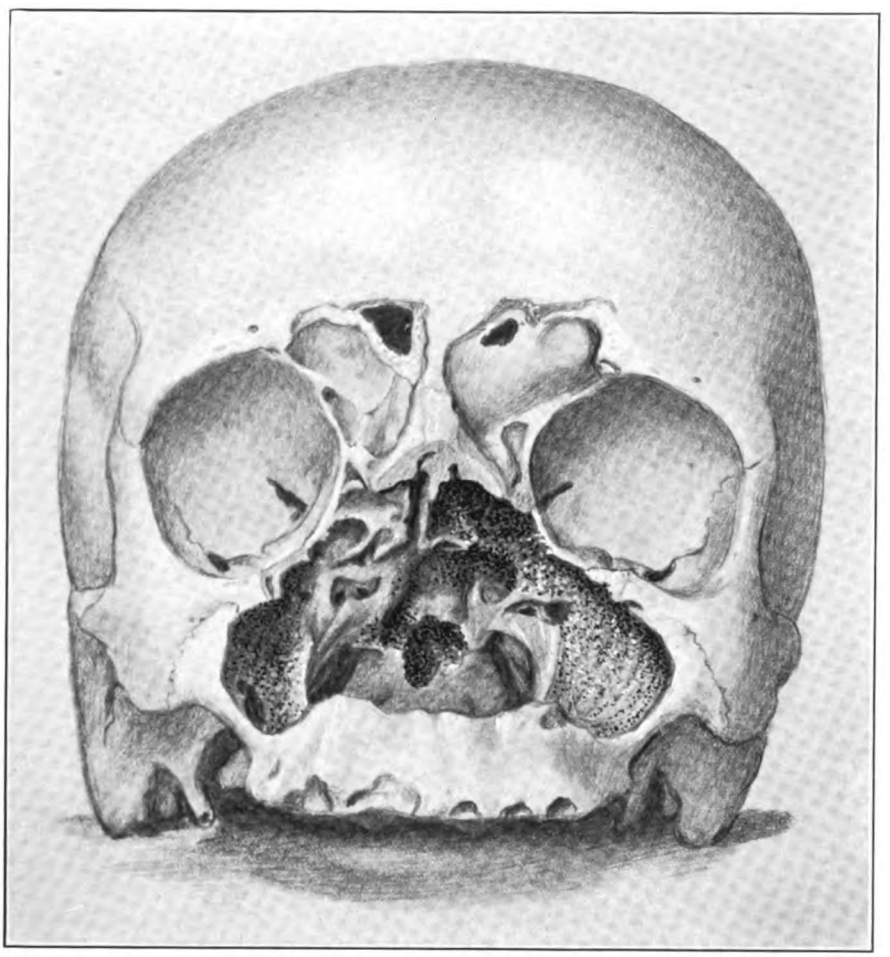


Plate X shows complete exposure of the frontal sinuses and a vertical section through the anterior nares. This specimen was interesting because of the extraordinary depth of the sinuses, the unusual height of the right sinus in the median line and its extension, particularly over the right eye, laterally and posteriorly. The large dimensions in three directions made a very commodious cavity. The septum separating the sinuses deviates toward the left. The openings of the nasofrontal ducts are about one centimeter from the median line and more than one centimeter posterior to the anterior wall. An incomplete secondary septum is seen well over the right eye; the portion of the sinus to the outer side of it passes far backward over the orbit, communicating with the other compartment of the sinus near the nasofrontal opening. The nasal septum is irregularly shaped with a spur formation on the right side below and a deflection to the left side at the center. In both nares are seen the middle and inferior turbinals. The interior of the nose presented nothing uncommon.

PLATE X

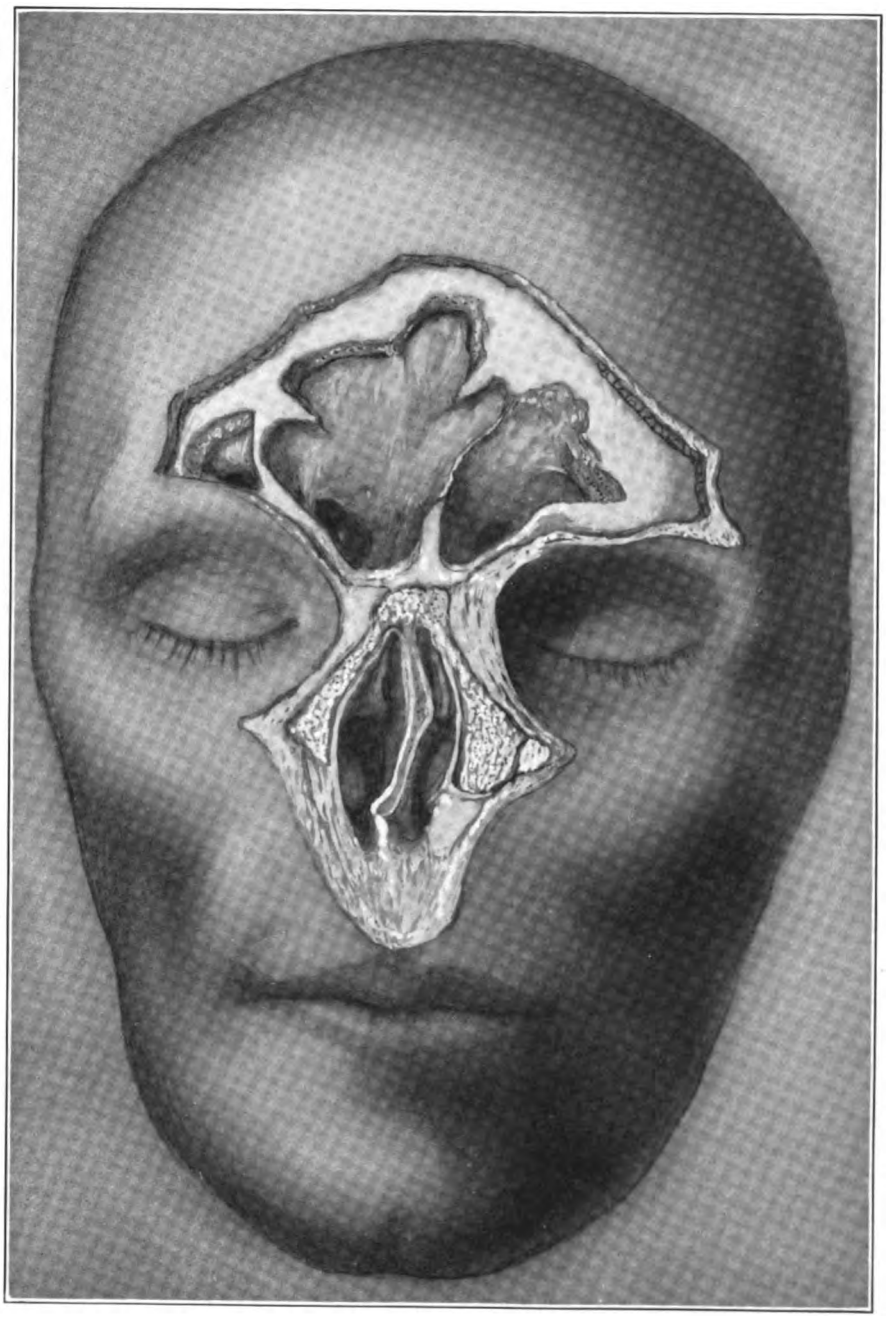


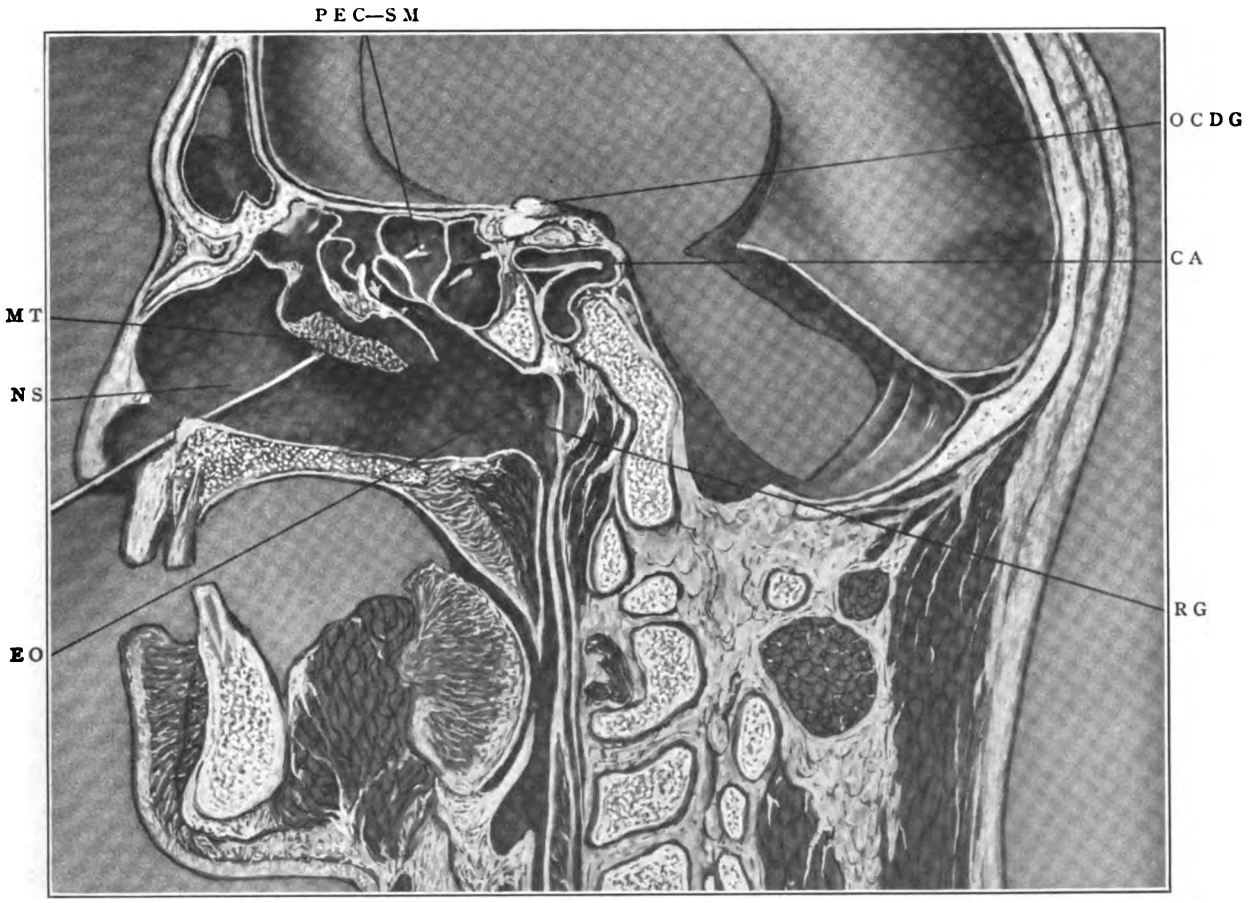
PLATE XI

C A, Carotid artery.
R G, Rosenmueller's groove.
C E T, Cartilage of Eustachian tube.
S S, Sphenoidal sinus.
P G, Pituitary gland.
P E C, Posterior ethmoid cells.
A E C, Anterior ethmoid cells.
N F D, Nasofrontal duct.
M T, Attachment for middle turbinal.
I T, Portion of inferior turbinal.
E O, Eustachian orifice.
C, Cannula in infundibulum.

Plate XI is a sagittal section to the left of the nasal septum showing the inferior turbinal partially cut away and the middle and superior turbinals removed, exposing the left frontal sinus, anterior and posterior ethmoidal cells and sphenoidal sinus. A probe cannula is seen in the infundibulum, the upward extension of which ends in the anterior ethmoidal cells. In this specimen, as is frequently the case, the frontal sinus and nasofrontal duct do not communicate directly with the infundibulum. In such a case it is impossible to introduce a probe into the sinus without making an artificial opening by destruction of some of the ethmoidal cells or their incomplete septa. Above the sphenoidal sinus is seen the pituitary gland with the dorsum sella posteriorly. Directly behind the sphenoidal sinus lies the carotid artery in its tortuous course. Below, the cartilage of the opening of the Eustachian tube has been partly cut through. The Eustachian orifice is anterior to it.

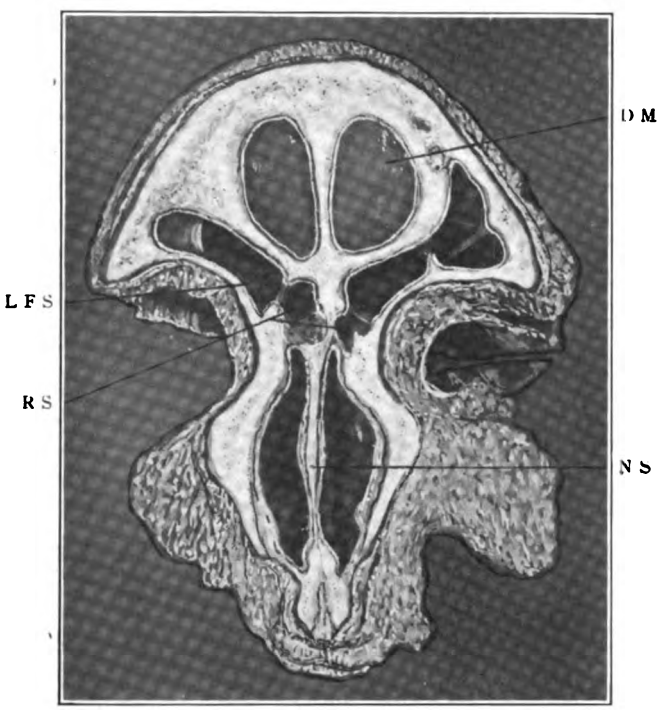
Plate XII represents the same section as the previous plate and shows the part lifted from the previous specimen. The section is still on the left side of the nasal septum and shows the portion of the middle turbinal which was raised from the previous specimen and demonstrates anterior and posterior ethmoidal cells and the sphenoidal sinus. An arrow indicates the opening of the posterior ethmoidal cell, and a probe cannula is introduced through the ostium of the sphenoidal sinus. The specimen contains but one especially large sphenoidal sinus without a septum and with but one ostium opening to the left side of the nasal septum. The tortuous course of the carotid canal is seen directly posterior to the sinus. Above and behind it is a section of the pituitary gland and of the optic chiasm. In the depth, posterior to the nasal septum, is the orifice of the right Eustachian tube. The specimen demonstrates the rule for probing the sphenoidal sinus, namely, that a probe or cannula directed upward and backward at an angle of 45 degrees with the floor of the nose can be introduced through the ostium of the sinus. Frequently the ostium is located a short distance (¼ to ½ cm.) laterally to the septum, and this necessitates bending the tip of the probe, which will then more readily find the opening when it is invisible. After medicating and douching the sinus it is advisable to force air into the sinus to remove all the fluid and secretions and to perform suction with the head bent well forward so that the ostium is at the most dependent point.

PLATE XII



M T, Portion of middle turbinal.
N S, Nasal septum.
E O, Eustachian orifice.
P E C—S M, Arrow passing from posterior ethmoid cell to superior meatus.
O C D G, Optic chiasm and pituitary gland.
C A, Carotid artery.
R G, Rosenmueller's groove.

PLATE XIII

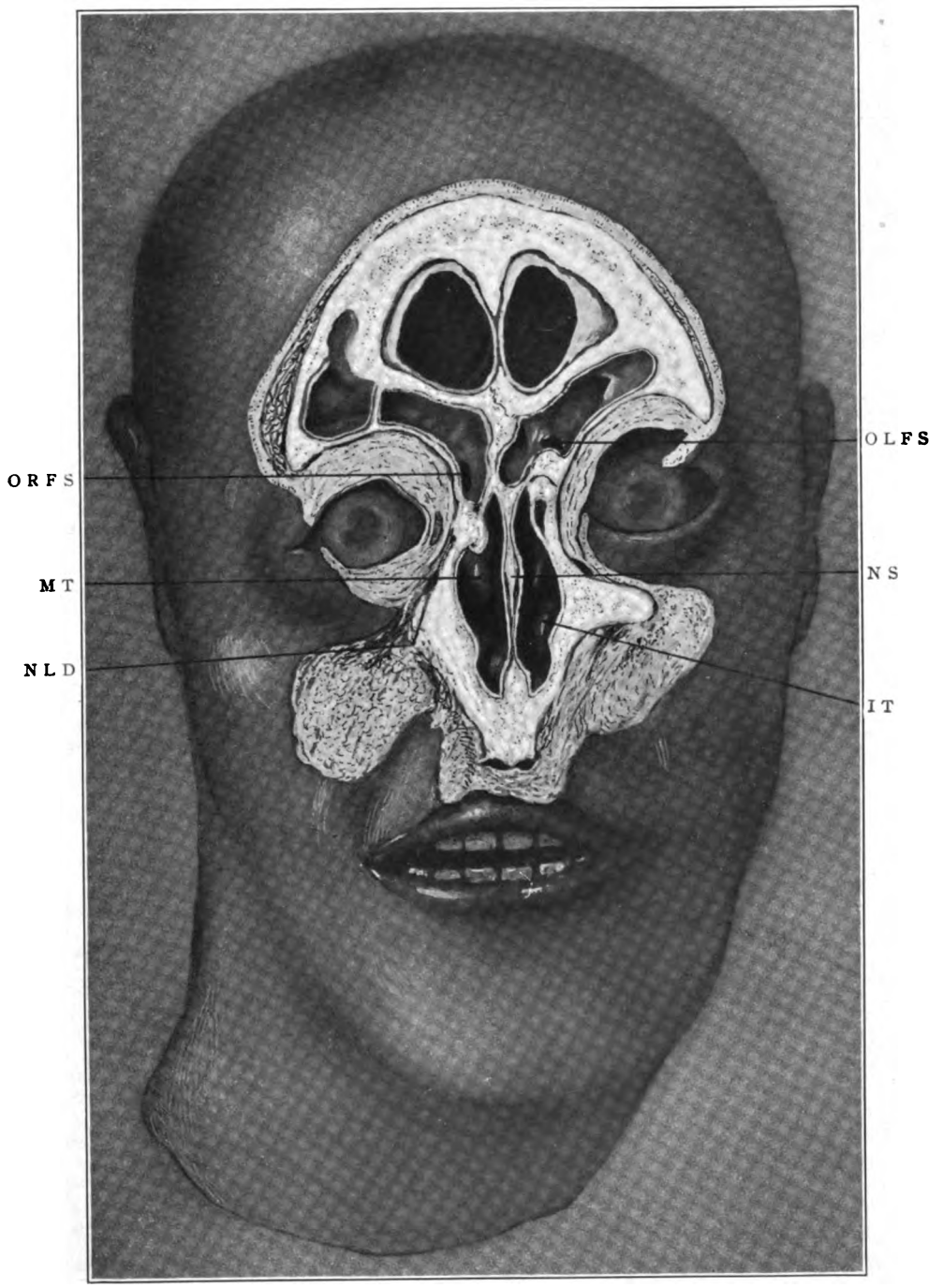


L F S, Left frontal sinus.
R S, Recesses of sinus separated by partial septa.
D M, Dura mater.
N S, Nasal septum.

Plate XIII represents a vertical section through the frontal bone including the nose, viewed from behind. Above, portions of the dura mater lining the anterior wall of the cranial cavity; below it and spreading laterally over both eyes, portions of the frontal sinuses with the septum dividing them displaced somewhat to the right of the nasal septum. There are secondary septa in each sinus. Below is the nasal septum with symmetrical nares.

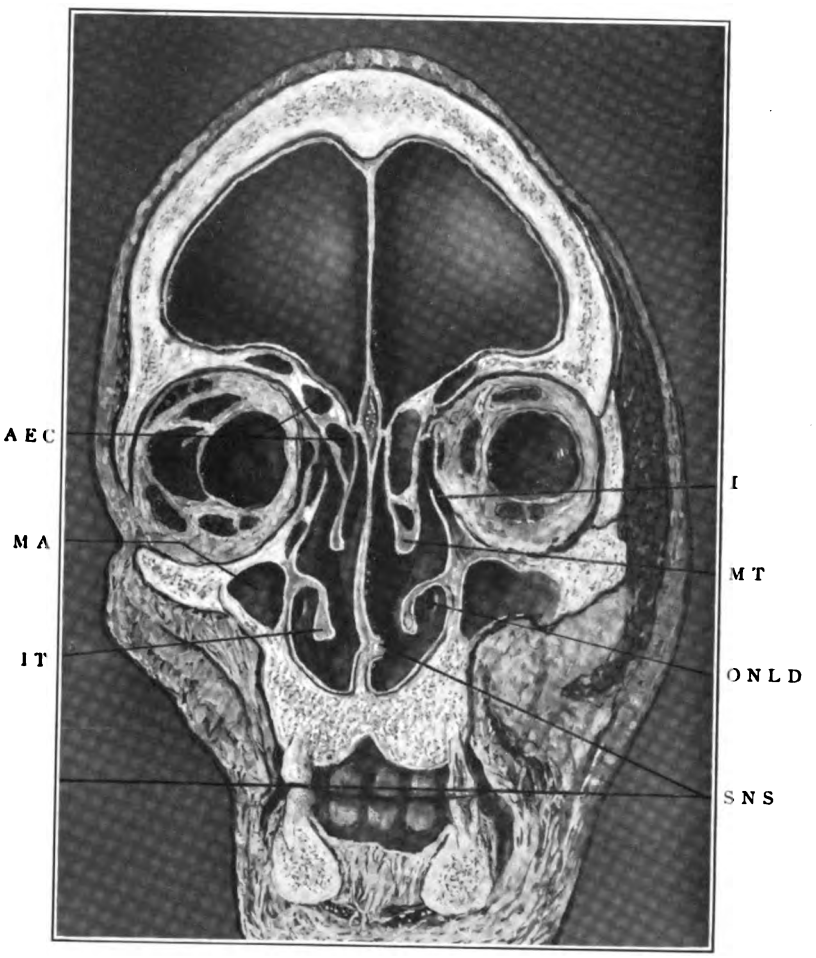
Plate XIV is a specimen representing the posterior aspect of the preceding plate (Plate XIII). Above, the cranial cavity has been exposed. Below this, two large frontal sinuses extend far over both orbits, showing elevations and secondary septa. The septum between the right and left frontal sinuses is to the right of the median line. The ostia of the sinuses are located about one centimeter from the median line. The one on the right is low near the most dependent point of the sinus. The one on the left side is one centimeter above the most dependent point. In inflammatory processes in the latter, the secretions would be retained irrespective of posture and most probably would necessitate an external operation. Below is seen a well-formed septum, the middle and lower turbinals showing on both sides. A portion of the nasolachrymal duct has been exposed on either side.

PLATE XIV



O R F S, Ostium of right frontal sinus.
M T, Middle turbinal.
N L D, Nasolachrymal duct.
O L F S, Ostium of left frontal sinus.
N S, Nasal septum.
I T, Inferior turbinal.

PLATE XV

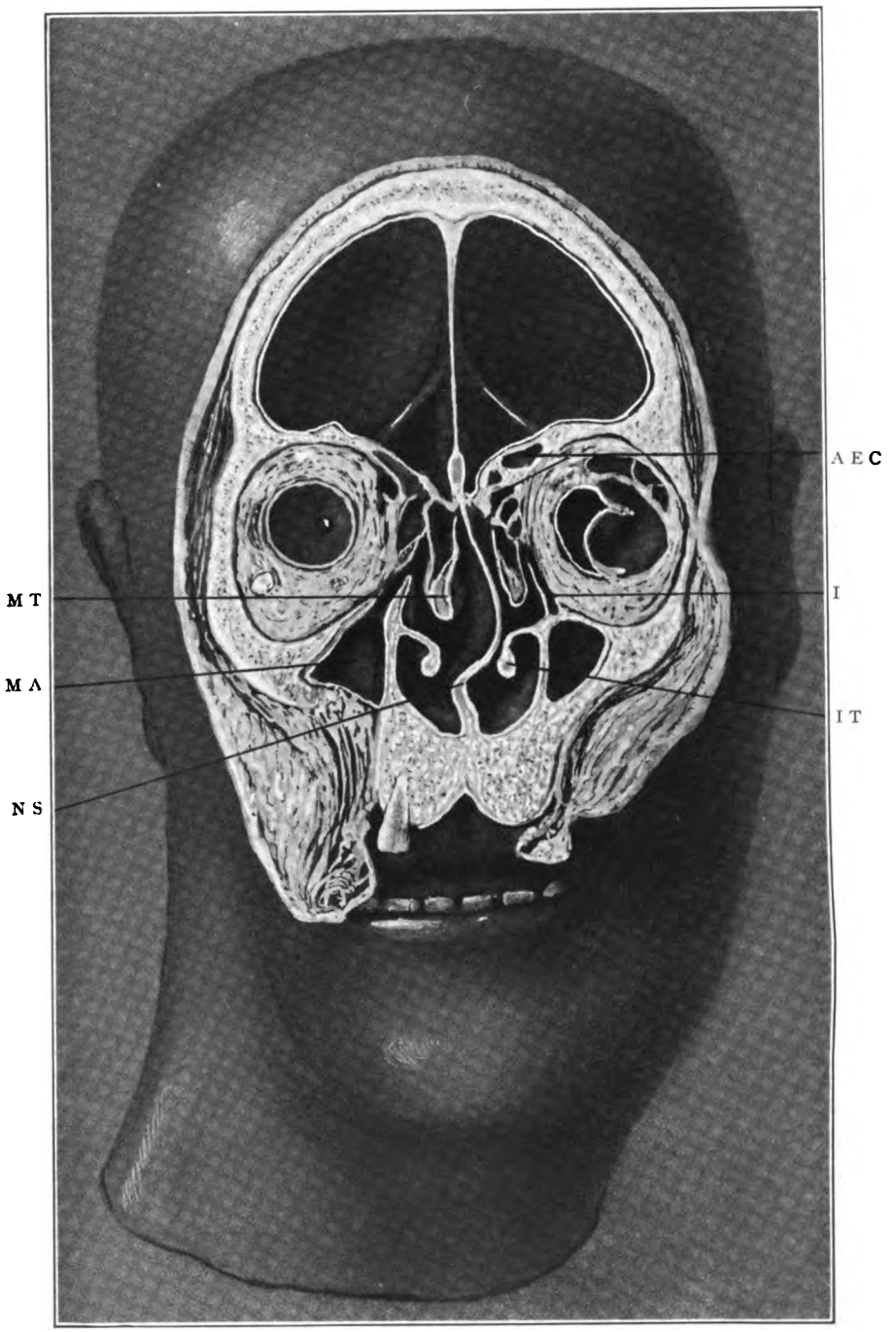


A E C, Anterior ethmoid cells.
M A, Maxillary antrum.
I T, Inferior turbinal.
I, Infundibulum.
M T, Middle turbinal.
O N L D, Orifice of nasolachrymal duct.
S N S, Spur formation on nasal septum.

Plate XV represents a vertical section about one centimeter posterior to the previous one (Plate XIII), as seen from behind. Below the cerebral cavity are seen the middle turbinals and anterior ethmoidal cells. In both nares the uncinate process forms the groove or infundibulum which in this specimen was continuous with the nasofrontal duct. Below this is seen the inferior turbinal sheltering the lower opening of the nasolachrymal duct. External to the lateral walls of the nose are the beginning of the maxillary antra on either side. The nasal septum shows a spur formation near its lower end.

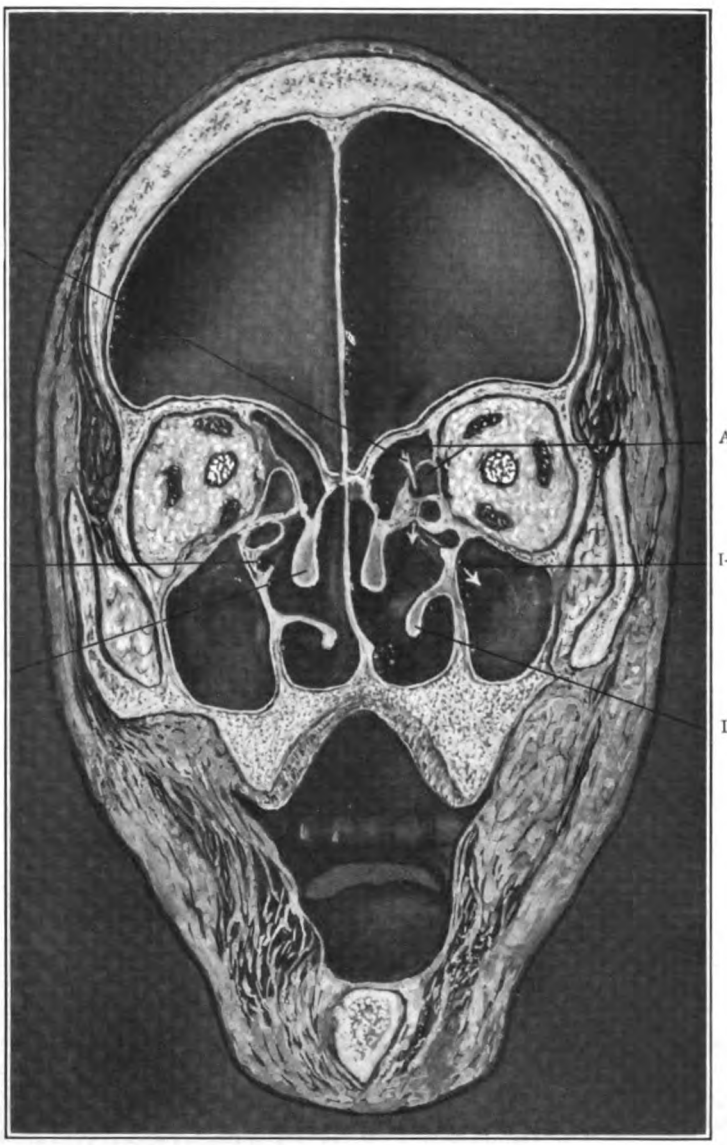
Plate XVI represents the same section as Plate XV, seen from in front. Below the cranial cavity are the ethmoidal cells reaching high up on the orbital wall. To the outer side of the middle turbinals are the uncinate processes forming the infundibuli. The right side shows a cross section of the ostium of the maxillary antrum opening into the infundibulum. Lower down the inferior turbinals and laterally the maxillary antrum are seen. The upper two-thirds of the nasal septum is deflected to the left.

PLATE XVI



M T, Middle turbinal.
M A, Maxillary antrum.
N S, Nasal septum.
A E C, Anterior ethmoid cells.
I, Infundibulum.
I T, Inferior turbinal.

PLATE XVII

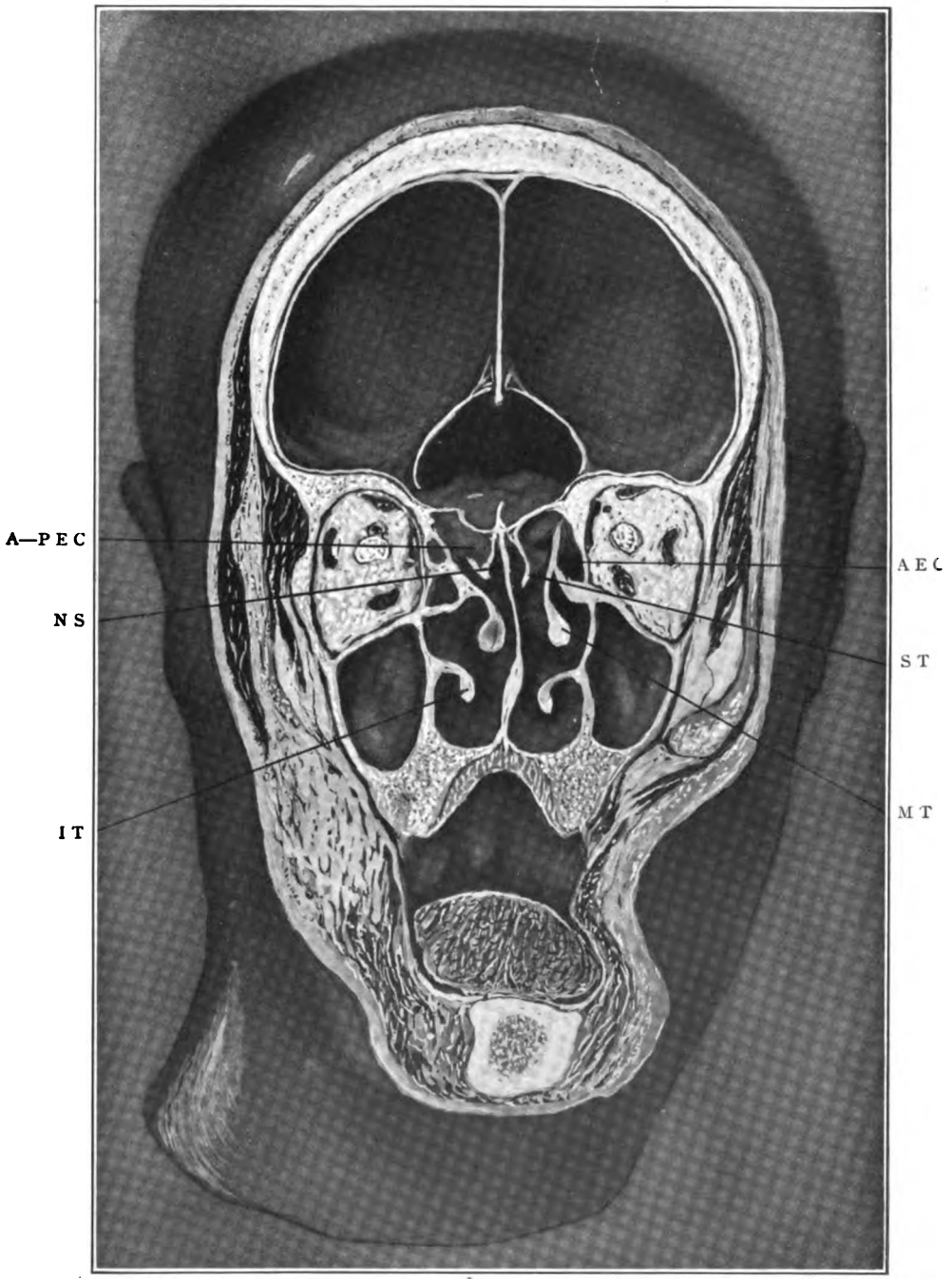


O A E C—M M, Arrow passing through ostium of anterior ethmoid cell to middle meatus.
U P, Uncinate process.
M T, Middle turbinal.
A E C, Anterior ethmoid cells.
I—O M A, Arrow passing through infundibulum and emerging at ostium of maxillary antrum.
I T, Inferior turbinal.

Plate XVII shows a third section, about one centimeter posterior to the section shown in Plate XV. The depression corresponding to the cribriform plate is well marked and demonstrates, as was stated in connection with Plate VI, that it corresponds in height to the inner canthus of the eye externally and, as is seen in this specimen, to the height of the optic nerve (middle of eye) posteriorly. In the nose are seen the middle turbinals with well-formed ethmoidal cells presenting distinct ostia on the right side. An arrow through one of these ostia indicates its communication with the middle meatus. Beneath the ethmoidal cells on either side are the slits (hiatus semilunaris) leading to the infundibuli. On the right side an arrow indicates the course of the infundibulum and emerges at the ostium of the maxillary antrum. In this specimen a probe introduced from above in the frontal sinus, through the nasofrontal duct, followed the course of the infundibulum directly into the maxillary antrum. This very readily explains how primary infection of the frontal sinus subsequently leads to secondary infection of the maxillary antrum. The secretions of the sinus flow through the nasofrontal duct into the infundibulum, as into a gutter emptying into the antrum. The inferior turbinals are well formed. The septum shows a spur formation at the lower end.

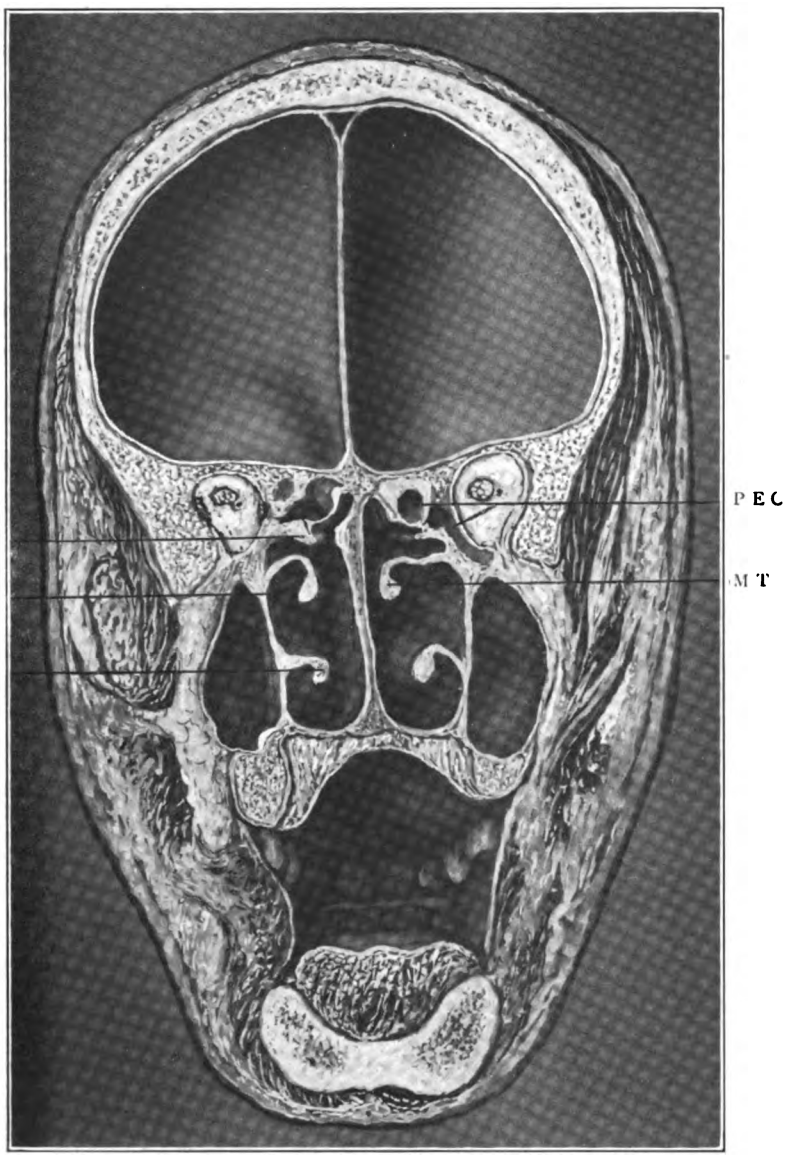
Plate XVIII represents the same section as previous plate (Plate XVII) seen from in front. In the cranial cavity is seen the falx cerebri with a cross section of the longitudinal sinus above and the tentorium cerebelli below. In the nose are seen for the first time the superior turbinals. This section corresponds to the midpoint of the nose. On the right side a partition separates the anterior and posterior ethmoidal cells. On the left are seen openings of the posterior ethmoidal cells. Beneath the middle and inferior turbinals are well formed meatuses. The maxillary antra are commodious and are now posterior to their ostia and the infundibuli. The uvula is seen in the depth of the mouth.

PLATE XVIII



A—P E C, Partition separating auterior and posterior ethmoid cells.
N S, Nasal septum.
I T, Inferior turbinal.
A E C, Anterior ethmoid cell.
S T, Superior turbinal.
M T, Middle turbinal.

PLATE XIX



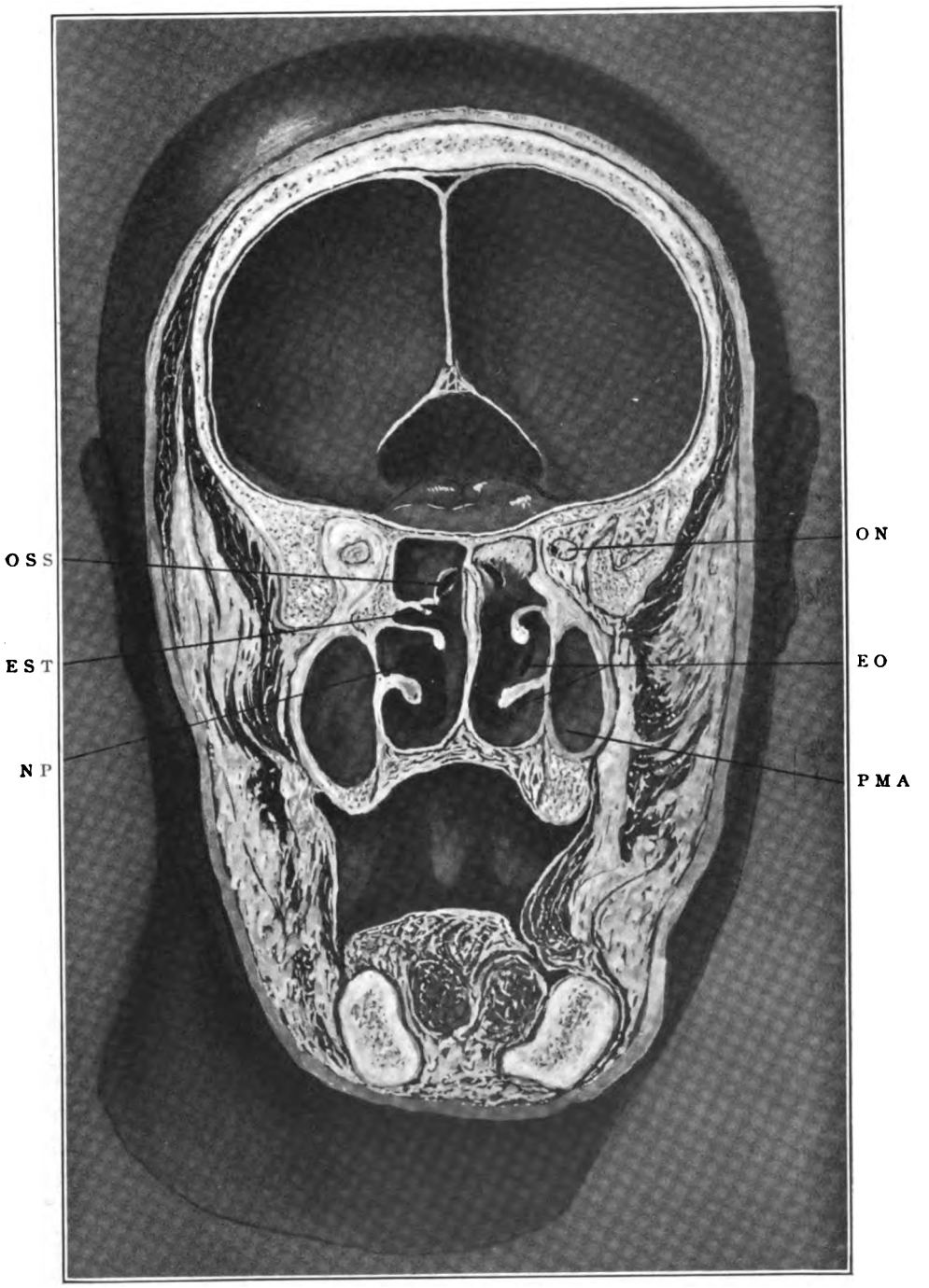
S T, Superior turbinal.
H S, Hiatus semilunaris.
I T, Inferior turbinal.
P E C, Posterior ethmoid cells
M T, Middle turbinal.

Plate XIX shows a section about one centimeter posterior to the section represented in Plate XVII. Below the cranial cavity are the posterior ethmoidal cells. Here the superior, middle and inferior turbinals are well demonstrated. On both sides the hiatus semilunaris is well forward. The maxillary antra show their greatest height. By the contracted appearance of adipose tissue around the optic nerve it is seen that the deepest portion of the orbit has been reached.

Plate XX. Below the cranial cavity are the anterior walls of the sphenoidal sinuses with their ostia, large and near the septum. In such a subject it would be comparatively easy to introduce a probe or probe-cannula according to directions given and demonstrated under Plate XII, *i. e.,* to introduce the instrument in an upward and backward direction at an angle of 45 degrees with the floor of the nose.

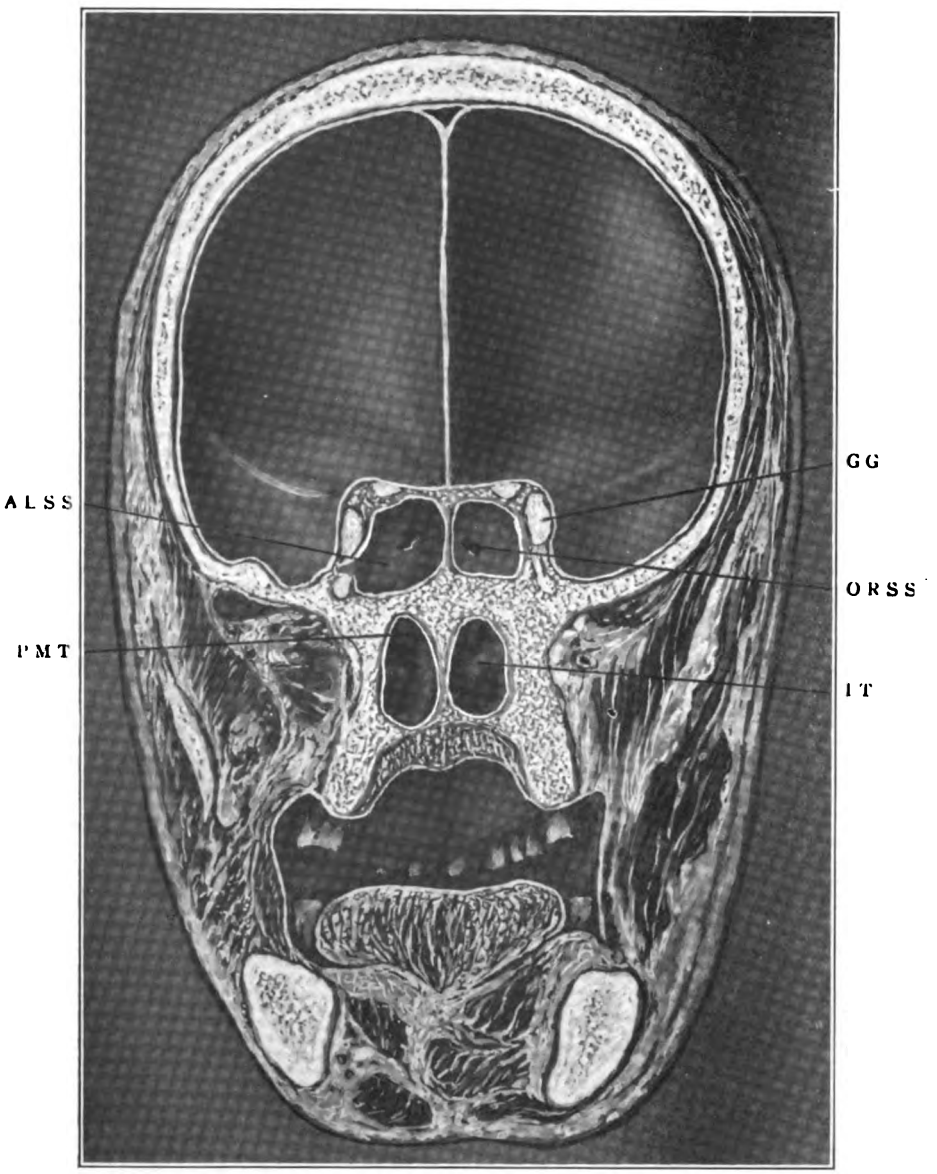
On the right side is the posterior end of the superior turbinal; on both sides the posterior ends of the middle and inferior turbinals; on the left side, in the depth, is the orifice of the Eustachian tube; laterally the posterior walls of the maxillary antra.

PLATE XX



O S S, Ostium of sphenoidal sinus.
E S T, End of superior turbinal.
N P, Nasopharynx.
O N, Optic nerve.
E O, Eustachian orifice.
P M A, Posterior wall of maxillary antrum.

PLATE XXI

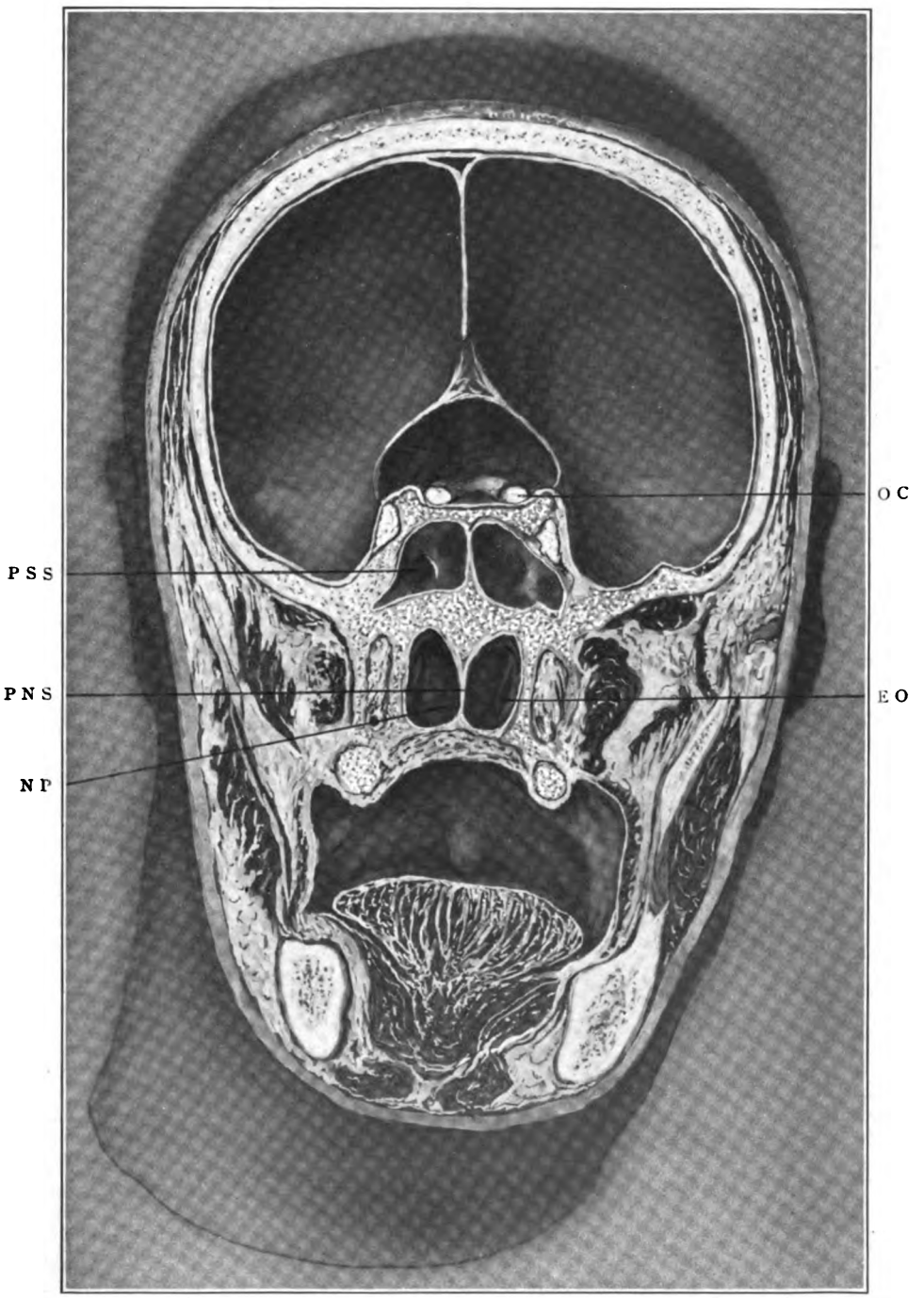


A L S S, Anterior wall of left sphenoidal sinus.
P M T, Posterior end of middle turbinal.
G G, Gasserian ganglion.
O R S S, Ostium of right sphenoidal sinus.
I T, Inferior turbinal.

Plate XXI represents a section about one centimeter posterior to that shown on Plate XIX. The cranial cavity shows the anterior fossæ above, the middle fossæ below. The Gasserian ganglia are seen on either side of the sphenoidal sinuses; the latter are separated by a well-formed perpendicular septum. The ostia are well up on the anterior wall of the sinuses. This demonstrates the necessity of placing the head well forward and downward, if drainage is to be effected through the natural openings of the sphenoidal sinuses, and also the advisability, in medication or irrigation, of following this with air pressure or suction or both. The nasal fossæ are greatly contracted and show the posterior ends of the middle and inferior turbinals.

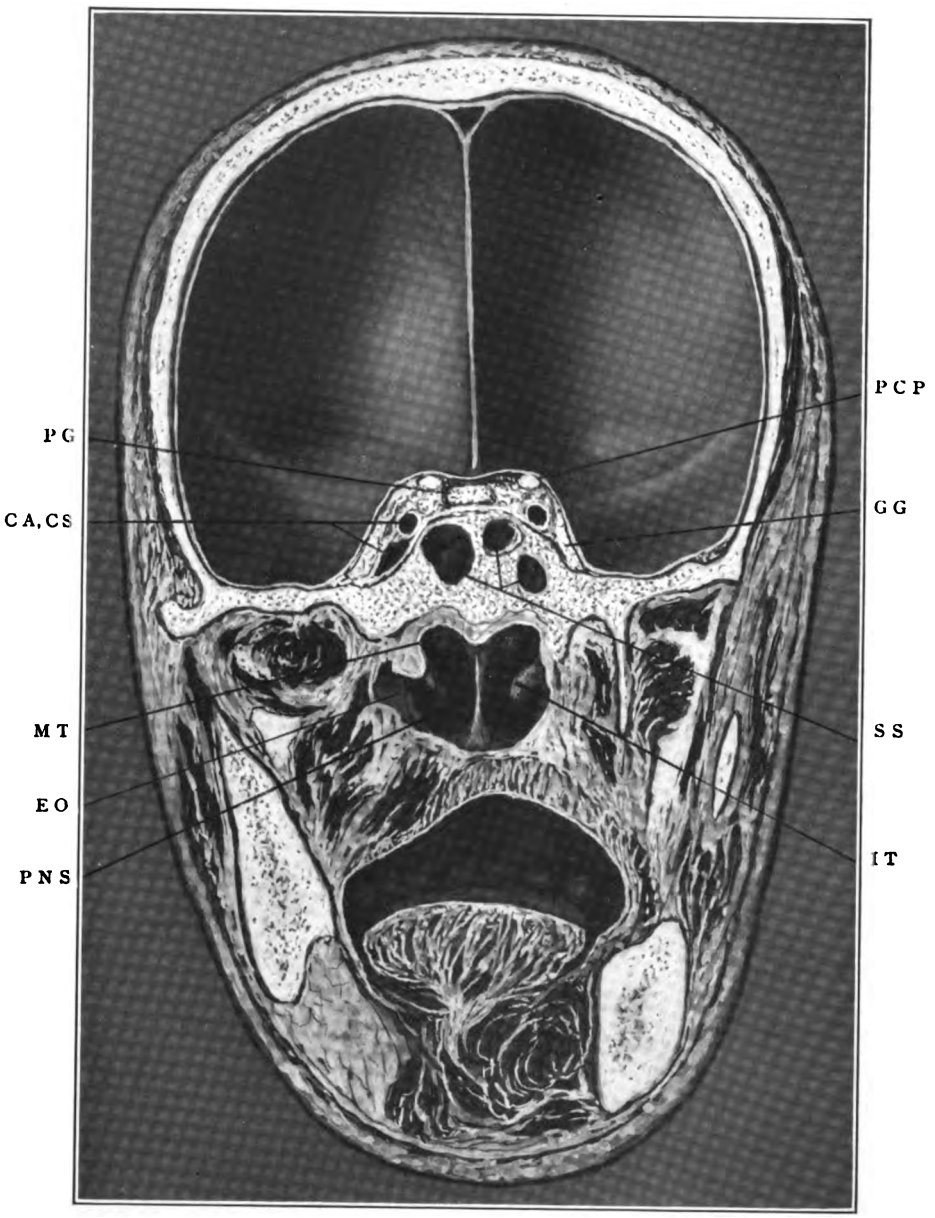
Plate XXII represents the same section as Plate XXI, seen from in front. Above the sphenoidal sinuses is a section of the optic chiasm. The posterior walls of the sphenoidal sinuses show irregular indentations. A considerable thickness of bone is seen between the sinuses above and the contracted nares below. In the middle line is the posterior end of the nasal septum. In the depth is the posterior wall of the nasopharynx. On either side the orifices of the Eustachian tube.

PLATE XXII



P S S, Posterior wall of sphenoidal sinus.
P N S, Posterior end of nasal septum.
N P, Nasopharynx.
O C, Optic chiasm.
E O, Eustachian orifice.

PLATE XXIII

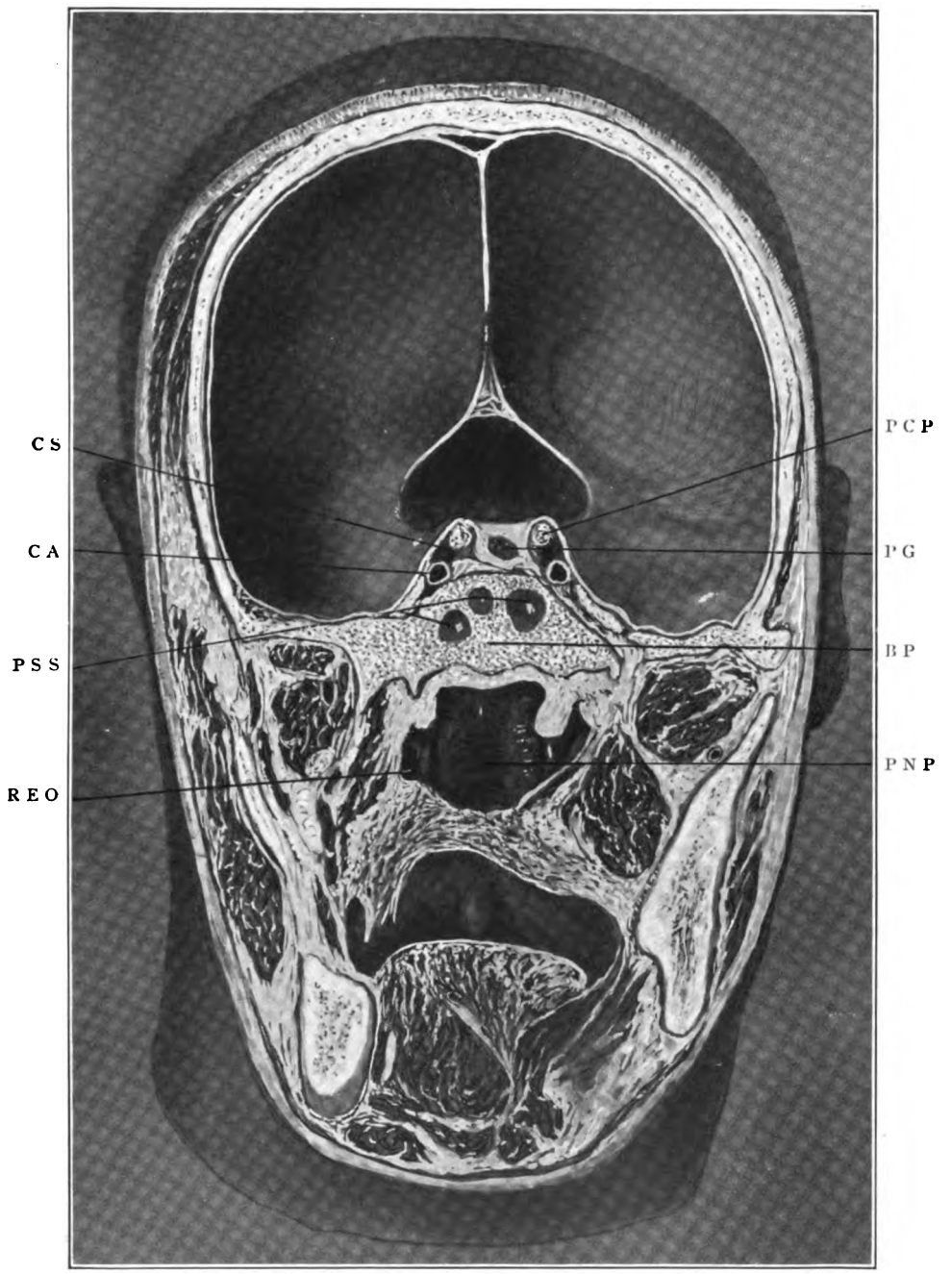


P G, Pituitary gland.
C A, C S, Carotid artery and cavernous sinus.
M T, Middle turbinal.
E O, Eustachian orifice.
P N S, Posterior end of nasal septum.
P C P, Posterior clinoid process.
G G, Gasserian ganglion.
S S, Openings into sphenoidal sinuses.
I T, Inferior turbinal.

Plate XXIII represents a vertical section of the head seen from behind, one centimeter posterior to section shown in Plate XXI. In the cranial cavity the orbits are shown as elevations on the floor of the anterior fossæ. The middle fossæ are seen on either side of a central mass which contains openings into the sphenoidal sinuses, the section having penetrated a part of their posterior walls. Above, the pituitary gland; laterally, the carotid arteries. On the right side is seen the Gasserian ganglion and on the left the cavernous sinus. Through the opening of the sphenoidal sinus on the left side is seen the ostium of the left sinus, as was more clearly demonstrated in Plate XXI. In the nose is seen the posterior edge of the nasal septum and the posterior ends of the middle and inferior turbinals. On the left side is a part of the orifice of the Eustachian tube. This specimen also demonstrates that a comparatively small pledget of gauze or cotton is required to occlude the posterior nares when it is desired to prevent blood from passing into the throat during a hemorrhage or a nasal operation. To occlude but one nostril a pledget the size of the end of a thumb will suffice.

Plate XXIV is the same section as is shown in the previous plate, seen from in front. In the cranial cavity the falx cerebri presents the section of the longitudinal sinus above, its divergence below forming the tentorium cerebelli. The central bony mass, which is a section through the sella turcica, shows the posterior clinoid processes. Centrally a portion of the pituitary gland is seen. Laterally the cavernous sinuses, the carotid arteries and Gasserian ganglia. The mucous lining of a portion of the posterior wall of the sphenoidal sinuses is seen in the bony mass. Below this the posterior wall of the nasopharynx, and laterally the orifices of the Eustachian tubes.

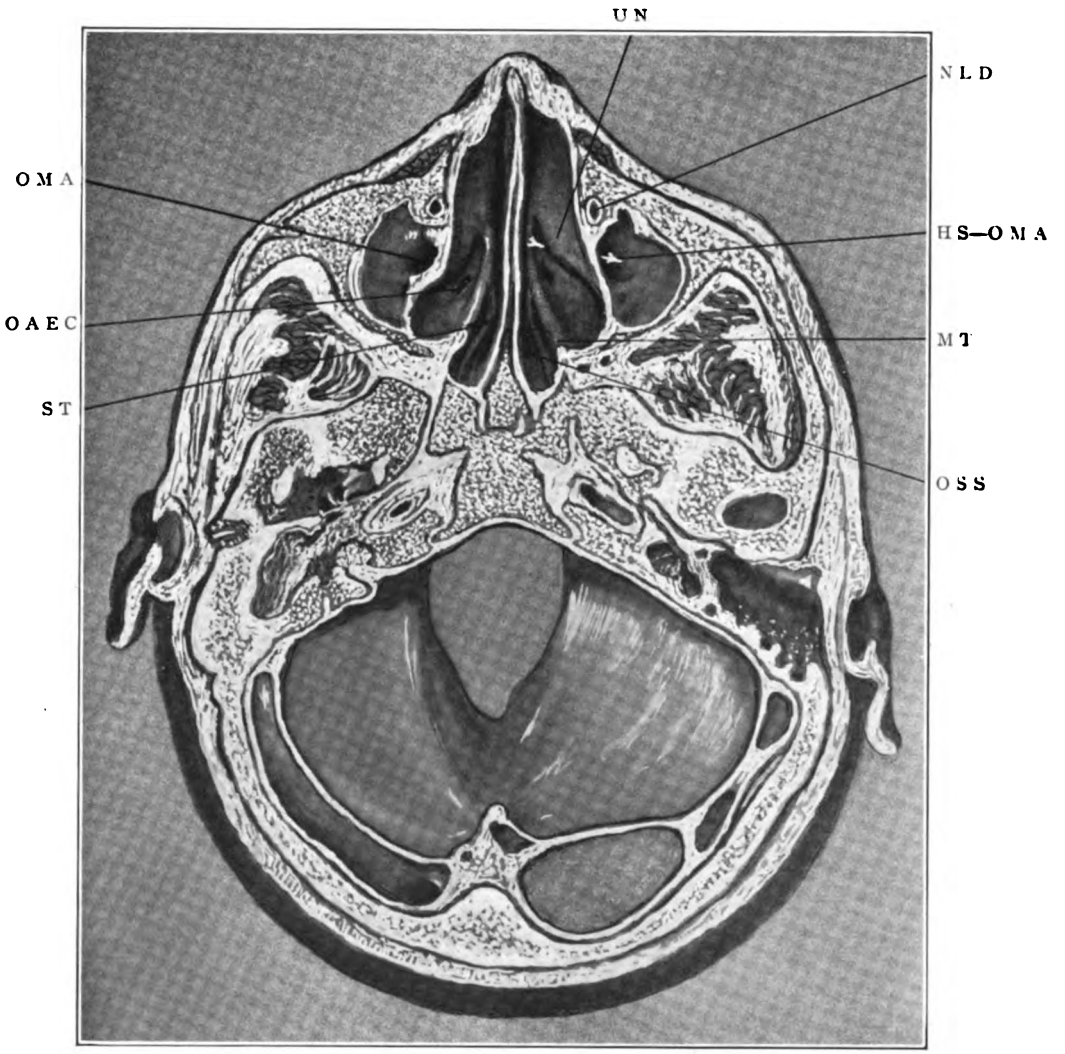
PLATE XXIV



C S, Cavernous sinus.
C A, Carotid artery.
P S S, Portion of posterior wall of sphenoidal sinus.
R E O, Right Eustachian orifice.
P C P, Posterior clinoid process.
P G, Portion of pituitary gland.
B P, Basilar process.
P N P, Posterior nasopharyngeal wall.

Plate XXV represents a horizontal section of the head through the middle of the nose as seen from below and shows the following anatomical features: In the middle line the nasal septum. The lateral wall of the nose shows the middle meatus, inferior aspect of the middle turbinal, hiatus semilunaris; and the openings from the anterior ethmoidal cells. An arrow passes through the hiatus semilunaris and infundibulum and emerges at the ostium of the maxillary antrum. Here, as in previous specimens, it is seen that the ostium is near the roof at the inner superior angle of the antrum and located somewhat anterior to its middle. Externally is the roof of the maxillary antrum. Posterior to the middle turbinals are the superior turbinals, and posterior and internal to these are the ostia of the sphenoidal sinuses. In front, between the lateral wall of the nose and the antrum, is a section of the nasolachrymal duct.

PLATE XXV



U N, Uncinate process.
O M A, Ostium of maxillary antrum.
O A E C, Ostium of anterior ethmoid cell.
S T, Superior turbinal.
N L D, Nasolachrymal duct.
H S—O M A, Arrow passing through hiatus semilunaris and emerging at ostium of maxillary antrum.
M T, Middle turbinal.
O S S, Ostium of sphenoidal sinus.

Plate XXVI. The heavy line over the right eye shows the beginning of the line of incision for exposure of the nasofrontal duct and frontal sinus. The lighter dotted line over the right eyebrow represents the incision for a sinus extending far laterally and is made continuous with the first incision. This incision is applicable if the entire anterior wall of the sinus is to be removed, or a ledge is to be left in place to support the soft parts. On the left side is seen the incision for an osteoplastic flap when probing through the nasofrontal duct has shown the sinus to be a large one. Marked depression would result if the entire bone were sacrificed. With the osteoplastic method the entire periosteum is left in contact with the bone; the bone is chiseled with a narrow thin osteotome on three sides, corresponding to the incision line. On the fourth side, which forms the base, the bone is nicked laterally so that it will break true in a straight line, when the osteoplastic flap is pried open from below. This should be done by a quick movement.

The dotted incisions starting at the sides of the pyriform fossa (bony nasal aperture) passing upward to the depression at the root of the nose with a cross cut joining the incisions on either side, demonstrate the method for exposing the interior of the nose as given in Chapter IV.

The incision on the left side at the junction of the gum and upper lip is the one chosen in most instances for exposure of the anterior wall of the maxillary antrum.

If the tissues are very firm and indurated and do not permit sufficient retraction of the soft parts to expose the entire anterior wall of the antrum, an incision as indicated on the right side, corresponding to the entire width and height of the anterior wall of the antrum, can be made to include either the soft parts alone or the latter with the bone attached.

PLATE XXVI

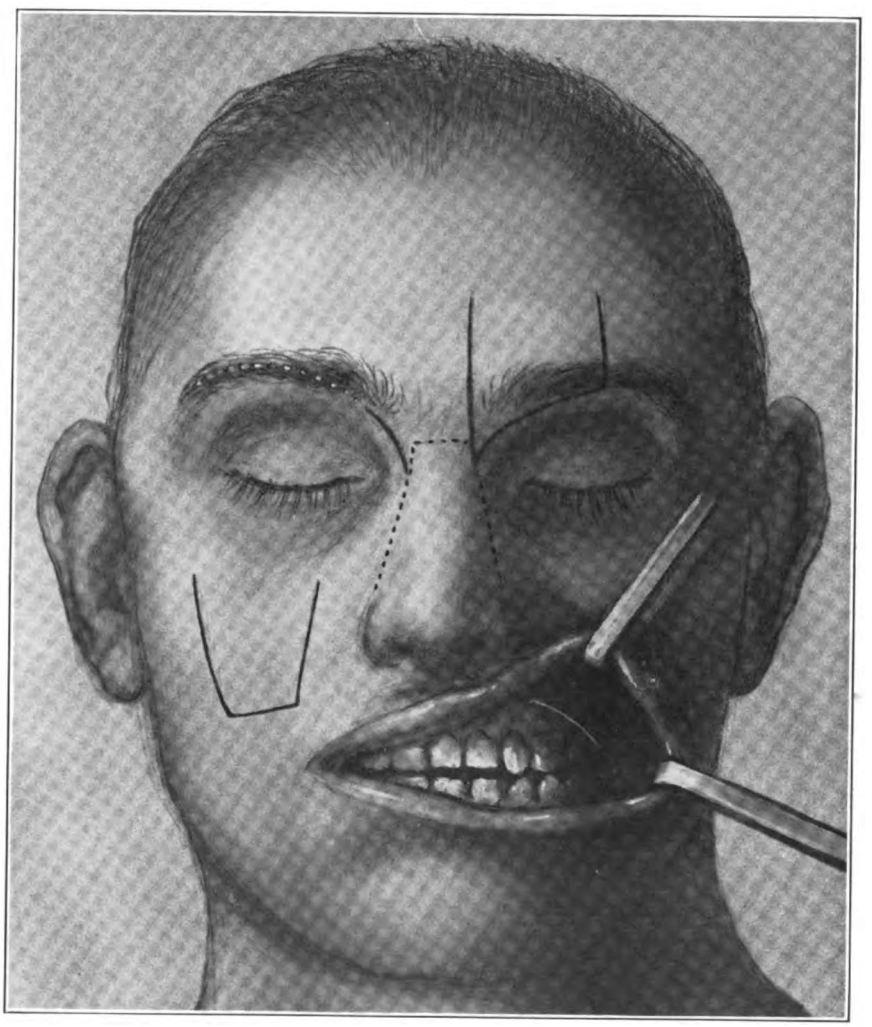
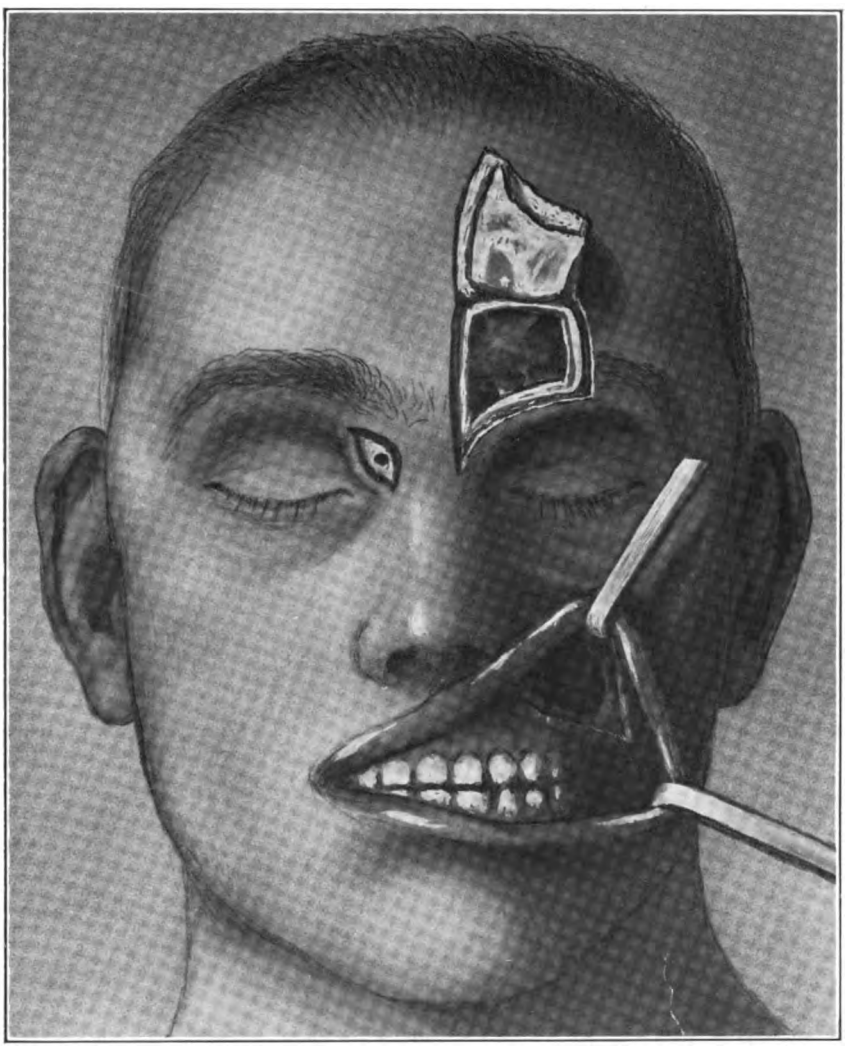


Plate XXVII shows on the right side beginning of the incision and the first stage of exposure of the frontal sinus. The soft parts have been incised at the inner canthus of the eye, in a direction upward and outward through the periosteum down to the bone. A borer, held in a direction upward and backward about one centimeter from the median line, has penetrated the bone to the nasofrontal duct. The probe is introduced through this opening into the sinus to determine its location and dimensions. When the sinus is small the opening is enlarged upward and laterally with chisel, burr or rongeur and thus exposed. When the sinus is large, one of two methods may be chosen. With the first, the incision is enlarged upward and outward and the periosteum of a ledge of bone, corresponding to the supraorbital ridge, is left undisturbed, while the periosteum above and below the intended ledge is incised and elevated from the bone. The bone of the anterior wall of the sinus is now completely removed above and below the ledge in order to expose every niche of the sinus. If the condition of the mucous membrane warrants, the latter can now be removed and any necrosed bone curetted. If the posterior wall of the sinus is curetted, great care must be taken to avoid injury to the dura mater. A probe is now passed through the nasofrontal duct into the nose to determine its course. Thorough drainage is effected by enlarging the duct with burr or trocar, and tubing is introduced through which the first few after treatments are to be given. The preserved periosteum is now replaced, the external wound is sutured and subsequent treatments are carried out intranasally.

PLATE XXVII



On the left side is shown exposure of the sinus by the osteoplastic method, for which the indications and technic were given in the description of the previous plate. After the original incision and boring of the bone, the exact height and width of the very large sinus must be determined by the curved probe. The first incision is carried outward along the supraorbital ridge. The second upward from the point of beginning, and the third vertically upward from the end of the first, corresponding in height to its parallel. The interior of the sinus is dealt with as described in the previous method and the flap is replaced, the periosteum being sewed first, the skin suture being completed without draining the cavity other than intranasally.

On the left side below is shown the interior of the maxillary antrum. The parts have been incised down to the bone beginning close to the outer border of the pyriform fossa and extending outward. The periosteum has been elevated from the anterior wall up to and on either side of the infraorbital vessels and nerve. Chiseling is now begun in the center of the antral wall and gradually enlarged downward to the alveolar ridge and then inward and outward and eventually upward, great care being taken not to injure the infraorbital canal and its structures. The bone on either side of the infraorbital should be removed to the edge of the orbit. The antrum is now completely exposed and can be dealt with according to indications. (See Plate VI.)

The radical exposure of the antrum is warranted only in chronic conditions where diseased membrane, eroded bone, polypi or growths are suspected. All the more acute and simpler conditions are treated by the intranasal method. If the lining of the antrum is to be left in place, a drainage opening should

be made at the lower part of the inner wall, the size to be determined by the amount of secretion it is necessary to drain. A small opening can be made by a trocar, as referred to in the article previously mentioned, a large one with a fraise or bone-biting forceps. If the lining membrane must be removed, the cavity can be treated in the following manner: The mucous membrane of the lateral wall of the nose of the corresponding side is elevated from its underlying bone, the inferior turbinal being cut away at its attachment or included in the membranous flap. This can be easily done by introducing the periosteal elevator at the edge of the bone on the side of the pyriform fossa, and working backward. After the membrane is completely loosened the inner bony wall of the antrum is removed with bone-biting forceps through the opening made in the anterior antral wall. The membranous wall in the nose is now severed close to the floor and brought into the antral cavity to form its new lining. This is pressed firmly against the bone and held in place by gauze packing. If the tension on the membranous periosteal flap is too great, vertical incisions should be made at either end.

With the simpler procedure the incision through the gum can be completely sutured and the after-treatment is carried out intranasally. For the more extensive procedure the packing for holding the membranoperiosteal flap against the antral walls can best be done through the original incision and the latter permitted to close immediately after the membranoperiosteal flap has become adherent.

Plate XXVIII shows on the right side an osteoplastic flap corresponding to the incision shown in Plate XXVI. The soft parts have been incised down to the bone, the periosteum has been pushed away slightly in the direction away from the osteoplastic flap and a thin narrow osteotome has pierced the anterior wall about one-half centimeter to the outer side of the edge of the pyriform fossa directly above the alveolar process. From here the bony incision is continued to a point close to the outer edge of the superior maxilla. From the ends of this incision the bone is chiseled upward close to the infra-orbital ridge. At the base of the flap the bone has been nicked on both sides and the trap door pried open from below.

The plate also depicts the nasal flap turned down after the bony structure had been severed by the Gigli saw following the course of the primary incision (Plate XXVI). The remaining cartilage of the septum has been cut to permit complete depression of the flap. In the interior of the nose is seen a septum with a central enlargement, protruding more into the right nostril. On either side are the middle and inferior turbinals and in the left nares the lateral wall of the middle meatus. This exposure permits partial or complete removal of the entire interior structure of the nose. By removing a wedge-shaped section of the septum the anterior wall of the sphenoidal sinus can be exposed and removed without interference of any other structure. Also, the anterior and posterior ethmoid cells or the ethmoids and sphenoidal sinuses can be exposed or removed without interference of the frontal sinus. If more room is required because of a deflected septum on the side to be operated upon, the septum can be severed close to the floor of the nose and temporarily pushed to the other side. If this does not suffice for necessary manipulations in the depth, the entire septum may be removed. The septum is severed with strong curved scissors near the roof of the nose, cutting straight backward until the sphenoidal sinus is reached and then slantingly downward along its anterior wall. A strip of septum sufficient to facilitate control of hemorrhage should be left along the roof. If it is necessary to remove the turbinals, this can be done with straight scissors. The ethmoid cells are most readily opened with a bone curette. When the orbital plate is reached this presents a decidedly greater resistance than the partition walls between cells and serves as a barrier between the field of operation and the contents of the orbit. The same resistance is met at the cribriform plate and will thus prevent injury to the dura mater.

PLATE XXVIII

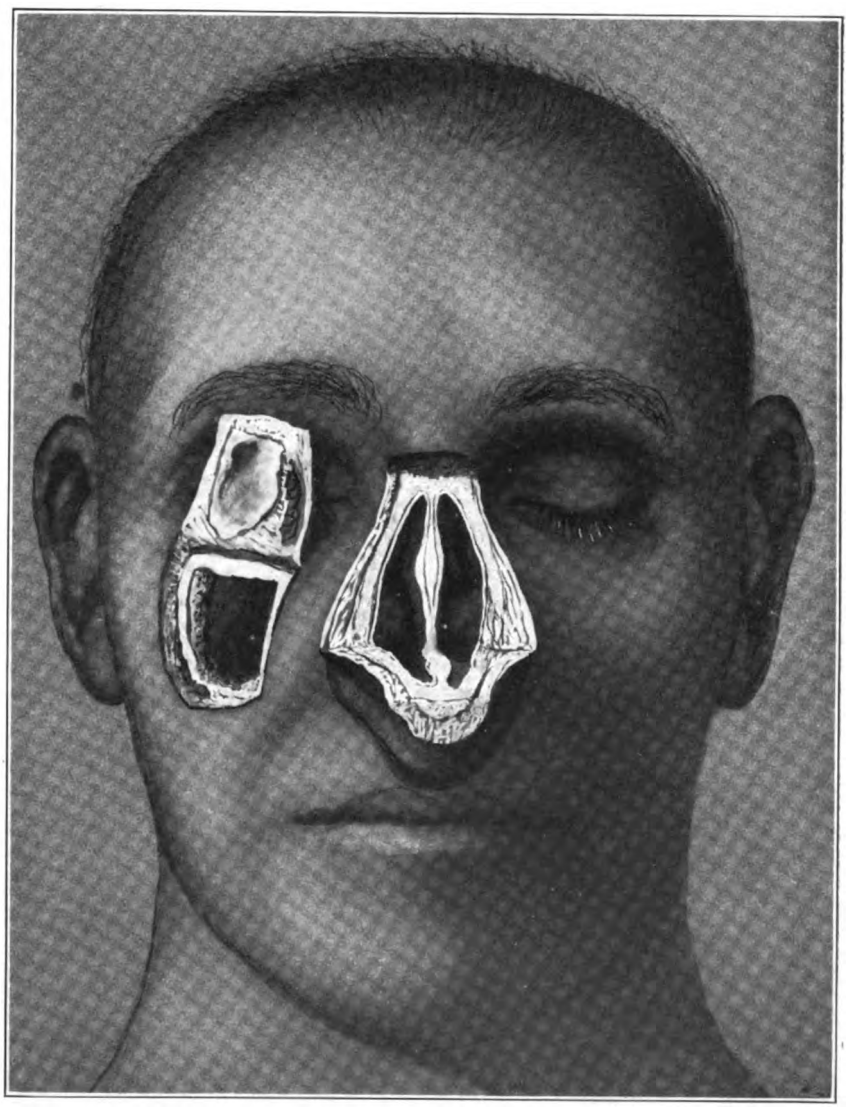
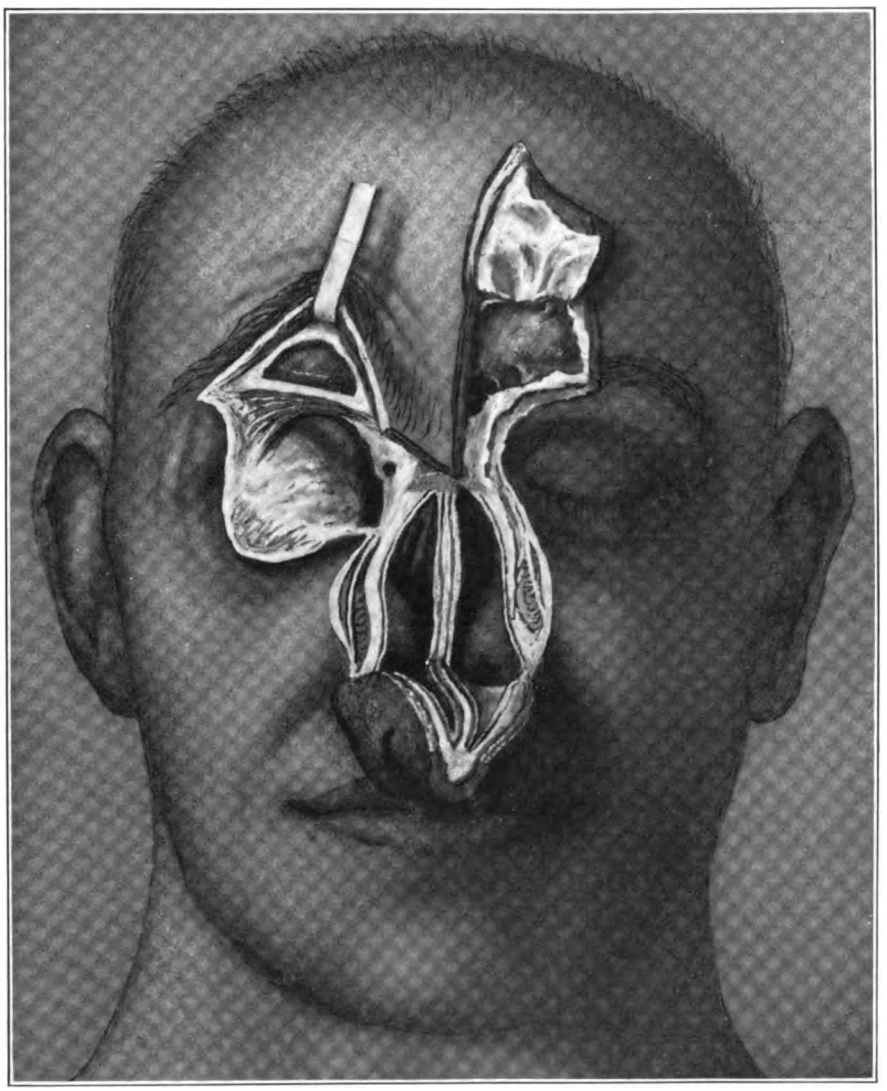


Plate XXIX shows on the right side the exposure of a large frontal sinus, above and below the supraorbital ridge, a ledge of bone having been left behind for support of the tissues. Through the lower opening a bone curette was passed backward, breaking down the partitions between the ethmoid cells. Eventually, the sphenoidal sinus was penetrated.

By looking into the nose it can be seen that the middle turbinal has been preserved on the right side. This procedure is similar to the Killian operation. On the left side of the nose, in contrast to this, removal of the ethmoid cells and of the sphenoidal sinus, as described in connection with the previous plate, is shown by the nasal flap method. After employing the above two methods for removal of ethmoid cells and sphenoidal sinus on a large number of subjects, the latter method, *i. e.,* by the nasal route, has been found much simpler of execution, more thorough and gives a far better oversight.

In this plate exposure of the frontal sinus on the left side is again shown by the osteoplastic flap method in comparison with the method for radical exposure, as shown on the right side.

PLATE XXIX



RÉSUMÉ

I

INTRODUCTION

On reflecting on the anatomical and surgical features present in the upper part of the respiratory tract, *i. e.*, the nose and its accessory sinuses, a number of important generalizations can be made which should serve as guides in treatment and operative procedures in that region.

Inspection of a skull in which the bone is sufficiently transparent on the inner wall of the orbit, will show that the anterior and posterior ethmoid cells extend upward to a point on a line with the inner canthus of the eye (Plate VI). Also, on looking from above and comparing the cribriform plate with a landmark on the face (Plate XI) or looking into the nose from below (Plates VII, XIV, XXVIII and XXIX), and noting the height of the roof, it will be seen that they, too, correspond to this same point. Hence, in order to avoid penetrating the anterior cerebral fossa, no instrumentation within the nose, posterior to the nasofrontal duct, should be done higher than a point corresponding to the inner canthus of the eye.

Another point of interest is that asymmetry in the nose is the general rule. Beginning with the septum it is found that in the majority of patients, as well as in anatomical subjects, there is a deviation to one side or the other, or a projection in the form of a spur. Our attitude toward this condition should be conservative, that is, not to meditate on the immediate removal of every prominence and projection simply because it exists, but to interfere only when it is found that a bony obstruction exists which prevents a sufficient volume of air from being inhaled through the nose to expand the lungs to their full capacity, or when insufficiency on one or the other side influences the hearing apparatus. Oftentimes the swollen turbinal lying against the projection is the cause of the obstruction, and with proper treatment this will in due time assume its correct proportions.

Asymmetry of the sinuses is well demonstrated by the specimens shown in Plates VII, VIII and X, the first of which presents a large left frontal sinus extending far over to the right side; the right frontal sinus is represented by merely a frontal cell. Plate VIII shows asymmetry in all the accessory sinuses, and a sinus spreading to both sides of the median line

and draining through a right-sided nasofrontal duct. On the left side the nasofrontal duct communicates with a small frontal cell. In this specimen it appears as though Nature had endeavored to counterbalance the parts by providing a small right-sided sphenoidal sinus for the large frontal sinus, and a large sphenoidal sinus on the left side for the small frontal sinus of that side. The maxillary antra also are asymmetrical.

II

EXPOSURE OF FRONTAL SINUS

If inflammation of the frontal sinus cannot be controlled by the conservative measures mentioned in the article previously referred to, an external operation becomes necessary. This is the case also if the lining membrane is chronically affected or necrosis of the bone or polypi are present.

An incision is made beginning at the inner canthus of the eye, curving outward and upward through the brow and ending short of the supraorbital vessels and nerves (Plate XXVI). The incision passes through the periosteum down to the bone, the purpose being to expose the nasofrontal duct. According to Plate VI it will be seen that the duct is located about one centimeter from the median line of the face. A borer is placed against the nasal bone at a point corresponding to the inner canthus of the eye and an opening large enough freely to admit a probe is made in a direction upward and backward (Plate XXVII). When the nasofrontal duct has been reached, the probe is introduced into the sinus to ascertain its size and one of the following methods determined upon. First, the opening is enlarged both upward and outward until the supraorbital ridge has been reached; with a small sinus all necessary inspection and instrumentation can be performed through such an opening and mucous membrane as well as diseased bone can be removed. Second, in the case of a larger sinus the same opening with another opening above the supraorbital ridge should be made, leaving a ledge of bone, about one-third of a centimeter in width, corresponding to the orbital ridge, to serve as a support for the soft parts, thus avoiding the deformity of a depression (Plate XXIX). In this instance the skin should be dissected up, but the periosteum corresponding to the ridge is left intact. Above the ridge the periosteum should be elevated and pushed upward as far as is necessary for the removal of the bone.

Third, for very large sinuses an osteoplastic flap can be formed by cutting the soft parts and chiseling the bone along the supraorbital arch, and making two perpendicular incisions from either end of this curved incision, the base of the flap being above (Plates XXVI, XXVII and XXIX). The exact size must be determined by means of a probe introduced through the original incision exposing the nasofrontal duct. The plate of bone is raised by means of an elevator or by any other firm instrument, and can be made to break more readily by nicking the bone on either side at the base line. After the interior is inspected the diseased membrane or polypi are removed or the necrosed bone is curetted, and the natural opening of the nasofrontal duct can be widened by introduction, in a direction downward and backward, of a trocar of any desirable size. A thick trocar will tear the mucous membrane of the canal as well as crush the partitions of the anterior ethmoid cells. Subsequent drainage is effected intranasally. The osteoplastic flap is turned down into place and pressed firmly to produce good adjustment of the bony edges. The periosteum and deeper tissues are sutured first, and suturing of the skin is completed without any opening for draining the sinus, but due regard must be given to drainage in case of purulent inflammation which might have occurred in the tissues external to the sinus or bone.

III

EXPOSURE OF MAXILLARY ANTRUM

If an inflammation of the maxillary antrum is not amenable to intranasal treatment as described in the previously mentioned article, owing to permanently chronically altered mucous membrane, polypi or necrosed bone, the radical exposure should consist in the removal of the anterior wall of the antrum by an incision through the alveolar-labial cleft (Plate XXVI). The incision passes through the soft parts down to the bone, the periosteum being elevated to the point near the infraorbital canal, care being taken to avoid injury to the infraorbital vessels and nerves (Plate XXVII). With a chisel, borer or burr the midpoint of the anterior wall is opened and extended in all directions, especially below, internally and externally. On account of the infraorbital canal, caution is necessary in approaching the upper part (Plate VI). Diseased membrane, polypi or necrosed bone can now be dealt with as necessary, and completely extirpated. For drainage a sufficiently large opening can now be made into the nose, preferably near the floor, but if the antrum

has been denuded of membrane or a large communication is desired, the entire inner bony wall of the antrum can be removed and the nasal mucous membrane can be cut into flaps with their attachment above, the inferior turbinal being included in the flap or removed and the membrane applied to the denuded walls of the antrum as described under Plate XXVII. In this way healing will be hastened. Intranasal drainage is preferable in every instance except when nasal membrane is to be used to line the antrum, in which case repacking of the cavity can be accomplished through the anterior wall.

If desirable to carry out the flap method as described under plates XXVI and XXVIII the tissues are incised to form a flap with its base above and including the entire anterior wall of the antrum.

After chiseling the bone on three sides, corresponding to the limits of the anterior wall of the antrum, the base line is nicked on either side and the bony plate pried open from below, with due care not to lacerate the vessels and nerve at the infraorbital canal. After treating the interior of the antrum by one or the other method as suggested above, the trap door is brought back into place. If the bone is involved and requires removal, this can now be done; if it is to be retained the osteoplastic flap is returned to its original position, the periosteum and deeper tissues sewed first and then the skin. If subsequent drainage and packing should be required, this can be accomplished by an opening into the mouth through the alveolar-labial cleft.

IV

EXPOSURE OF ETHMOIDAL CELLS AND SPHENOIDAL SINUSES

The location of the anterior and posterior ethmoidal cells and the sphenoidal sinuses is such that opening or removal of them is possible by intranasal operation.

The introduction of a probe cannula into the openings of anterior and posterior ethmoidal cells is practically impossible, owing to the labyrinthian nature of their arrangement.

On the other hand, the opening of the sphenoidal sinus can often be seen, but even if not seen it can be reached with a probe or probe-cannula by directing the latter upward and backward at an angle of 45 degrees with the floor of the nose. If the opening is some distance from the middle line, the end of the instrument should be slightly bent. When introduced in the direction stated, the end of the instrument will find the ostium by a turning movement.

The ethmoidal cells and sphenoidal sinus also can be reached through the incision for exposing the frontal sinus, and with due consideration to their external landmarks, as reiterated on the foregoing pages, can be made part of that exposure.

A third method of reaching the ethmoids and sphenoidal sinus is by the osteoplastic flap method of the nose described more fully further on. The advantage of the preceding method is that it leaves the turbinated bones intact, even though the ethmoid cells are completely eliminated, and the operation can be made part of the frontal sinus exposure if that has become necessary. If the latter is not the case, the osteoplastic flap method of the nose is far more advantageous for very complete removal of the lateral masses and exposure of the sphenoidal sinuses, and the view gained thereby is greater than by any other procedure.

V

EXPOSURE OF INTERIOR OF NOSE

As already stated, with the examination of a great number of skulls and comparison of the deeper structures with the landmarks on the face, it is found that the height of the cribriform plate and the uppermost ethmoidal cells correspond practically to the inner canthus of the eye; so that if the interior of the nose is exposed to this height, this level is the highest required for intranasal operations.

Hence in the case of extensive removal of the entire labyrinth and the sphenoidal sinus, or for removal of a tumor involving those parts, the best exposure can be obtained with the osteoplastic flap method, and interference with the frontal sinus or maxillary antrum becomes entirely unnecessary.

To expose the nose from in front, the simplest procedure and one that gives the best view is as follows: The first step is a transverse incision over the root of the nose. An incision is then made from the root downward on either side of the nose to the angle of the pyriform fossa. The tissues are cut directly through the periosteum to the bone. The soft parts to the outer side of these incisions are pushed back sufficiently to make way for the Gigli wire saw. The bone at the root of the nose is now sawed until a sufficient hold is acquired to continue the saw cut downward, corresponding to the incisions on either side until the angles of the pyriform fossa have been reached. On elevating the nose by raising the flap at the root (the patient

being in a prone position), the lower part of the septum will offer some resistance. The detached portion is then drawn downward, and if a complete depression of the loosened parts has not been effected, the cartilage of the septum which still remains can be incised until complete downward folding of the nose is secured. The alæ and the columna form the hinge on which it can be bent. (Plates XXVI and XXVIII.) The exposure thus effected corresponds practically to the full height and width of the nose and permits complete reposition without loss of tissue other than the minute line of bone through which the wire saw passes. With daylight, lamp and head mirror, electric head light or a small electric pencil, 4-5 inches long, which can be introduced on the side of the septum for direct illumination or on the opposite side for transillumination, the entire nasal cavity can be inspected. If the septum deviates to one side and the smaller cavity is to be operated upon, the septum can be cut with scissors from before backward, close to the floor of the nose and released in its full length; the entire septum can thus be pushed to the opposite side, giving ready access to the side to be operated upon. When this more radical procedure is unwarranted, sufficient space can be obtained by removing the deviated portion of the cartilaginous and bony septum lying between the two layers of the septal membrane. In septal involvement by a new growth, the septum can readily be removed in toto by severing its attachment above and below with curved scissors. The curved instrument is particularly applicable for the reason that the posterior portion of the septum corresponds to the slope of the sphenoidal sinus which forms the upper half of the nasal wall posteriorly, the lower half corresponding to the nasopharynx.

The view obtained with the exposure mentioned above shows the following important features on both sides: In the middle line the nasal septum, either straight or, as in most cases, slightly deviated in its upper or lower portion or both upper and lower portions, with or without spur formation. Laterally, above, the space between the middle turbinate bone and the septum extends to the roof of the nose, which is formed by the cribiform plate of the ethmoid. Further down is seen the fold or bridge formed by the anterior portion of the middle turbinal, which serves as a guide for introduction of instruments into the nasofrontal duct. This fold or bridge is generally removed by rhinologists who wish to treat the frontal sinus intranasally. Directly back of this fold in the middle of the meatus is the crescentic edge of the uncinate process extending from above and in front, downward and backward, which forms with the prominent ethmoid cell overhanging it, the slit

called hiatus semilunaris. This opens into the larger space or channel called the infundibulum, formed by the same anatomical structure as the hiatus, *i. e.*, the uncinate process of the ethmoid below and the bulla ethmoidalis above. The ostium of the maxillary antrum invariably opens into this channel or trough and generally also the nasofrontal duct, hence it is the usual deep guide for probing the nasofrontal duct and sinus. In most instances I have found that with a long probe-cannula bent into a semicircle about 8 centimeters in diameter, the point slightly curved outward, it is possible to enter the frontal sinus through the infundibulum and nasofrontal duct and to introduce cleansing solutions and medicaments in sinusitis without removal of a portion of the middle turbinate bone or any other operative procedure. In all cases of sinusitis it is well to try this mode of treatment before performing a more extensive procedure.

Below, the inferior turbinate bone and meatus are visible. Posteriorly the posterior wall of the nares is seen to be made up in its upper half by the sphenoidal sinus, the anterior wall slanting from the midpoint of the nose above, downward and backward, until it reaches the deeper recess of the nasopharynx, which forms the lower half of the posterior wall. At the upper part of the anterior wall of the sphenoidal sinuses are their ostea. It can be readily understood that when infection occurs in the sinuses, they can drain only when the head is bent forward until the face is in a horizontal or lower position, and this, too, only when swelling of the mucous membrane does not occlude the ostia.

To introduce a probe-cannula, the following procedure, described somewhat more fully than heretofore, should be carried out: Inasmuch as the ostia are situated near the upper part of the sinuses and the wall of the sinus begins at about the midpoint of the nose, a probe-cannula should be directed upward and backward between the middle turbinal and the septum at an angle of 45 degrees with the floor of the nose. If the ostia are located near the septum and the middle turbinals do not project unduly, this opening can be readily seen by anterior rhinoscopy and the probe or cannula introduced at sight. If the openings are further to the side, away from the septum and hidden by the middle turbinals, the instrument must be slightly bent at the end. By turning the curved end in an outward direction after it has reached the wall of the sinus, the tip of the cannula will find and slip through the opening. After irrigation of the sinus the patient should be directed to lower the head between the knees to avoid retention of fluid. When the condition in the sinus will not yield to conservative treatment the

entire anterior wall can be readily removed from the ostium downward intranasally or by the more radical exposure; but before this is resorted to, the simple irrigation with the probe-cannula through the natural opening should be employed.

In case of chronic inflammatory conditions and in new growths the anterior and posterior ethmoidal cells can be readily removed with a bone curette by the radical exposure after removal of the middle turbinal of the affected side. The parchmentlike partition walls with their delicate membrane break up readily with such an instrument and the greater firmness and resilience of the orbital wall and cribriform plate offer a safeguard against passing beyond these important barriers. Thus, after removal of the anterior wall of the sphenoidal sinus with the bone curette, it will be found that if a portion of the posterior or upper wall is to be removed, this can be accomplished only with a burr or chisel, and that the bone curette cannot effect the same.

The inferior turbinal can be cut away with curved scissors; the lateral wall of the nose, which corresponds to the inner wall of the antrum, can be crushed or removed with bone curette or bone-biting forceps in involvement of this part of the nose.

On inspecting the posterior and upper wall of the sphenoidal sinus, a prominence is seen which corresponds to the depression of the sella turcica and contains the pituitary body (Plate VIII). For the removal of the pituitary body the septum and middle and superior turbinals of both sides, the ethmoidal labyrinth and the anterior wall of the sphenoidal sinus must be removed, because as before mentioned, the pituitary body corresponds to the middle of the prominence in the sphenoidal sinus. Laterally to this midpoint, important structures will be encountered, *i.e.,* the cavernous sinus, carotid artery and chiasm. For removal of the entire septum curved scissors are used, the septum being severed at its upper and lower attachments.

Thus the method of exposure for the ethmoidal cells and sphenoidal sinus is preferable to the method from above through the frontal sinus or from below through the maxillary antrum, because all the parts are left in situ and no external deformity results, since the nose is replaced without loss of bone other than that caused by the width of the Gigli saw, the external scar being practically hidden in the natural depressions on either side of the nose or by artificial means, *i. e.,* the use of large rimmed spectacles.

IV

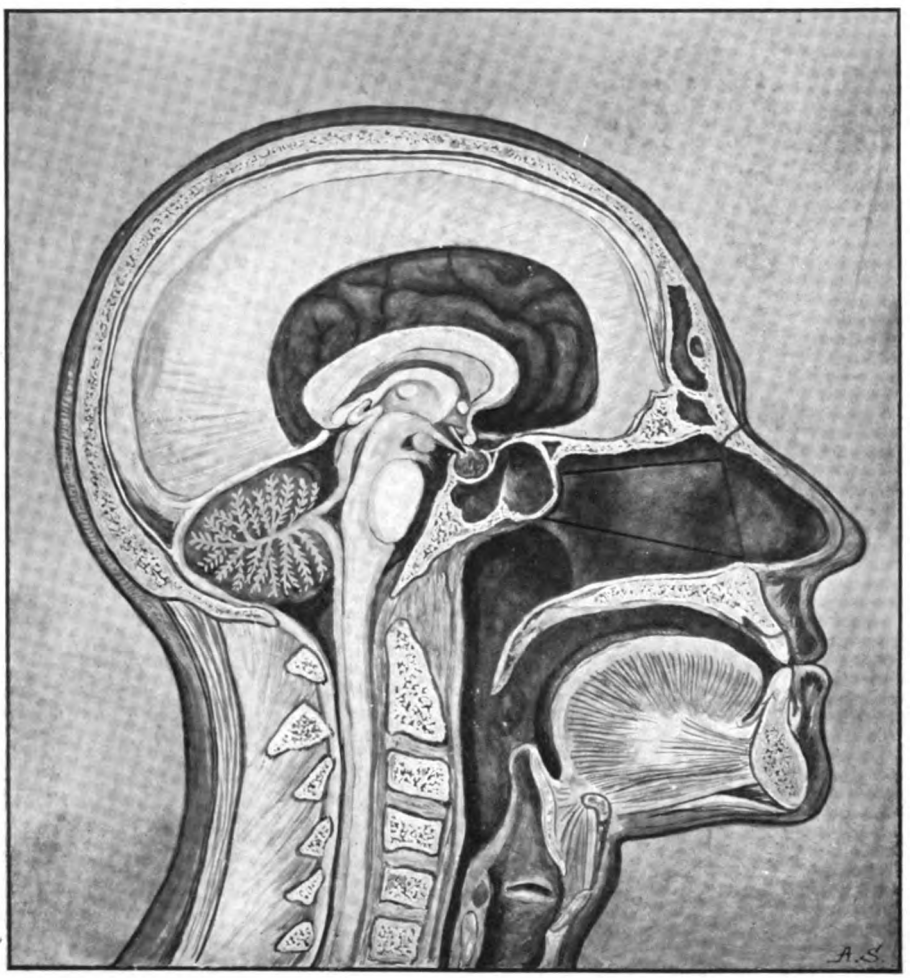
ANATOMICAL AND SURGICAL DESIDERATA IN THE EXPOSURE AND REMOVAL OF THE PITUITARY GLAND

IV

ANATOMICAL AND SURGICAL DESIDERATA IN THE EXPOSURE AND REMOVAL OF THE PITUITARY GLAND

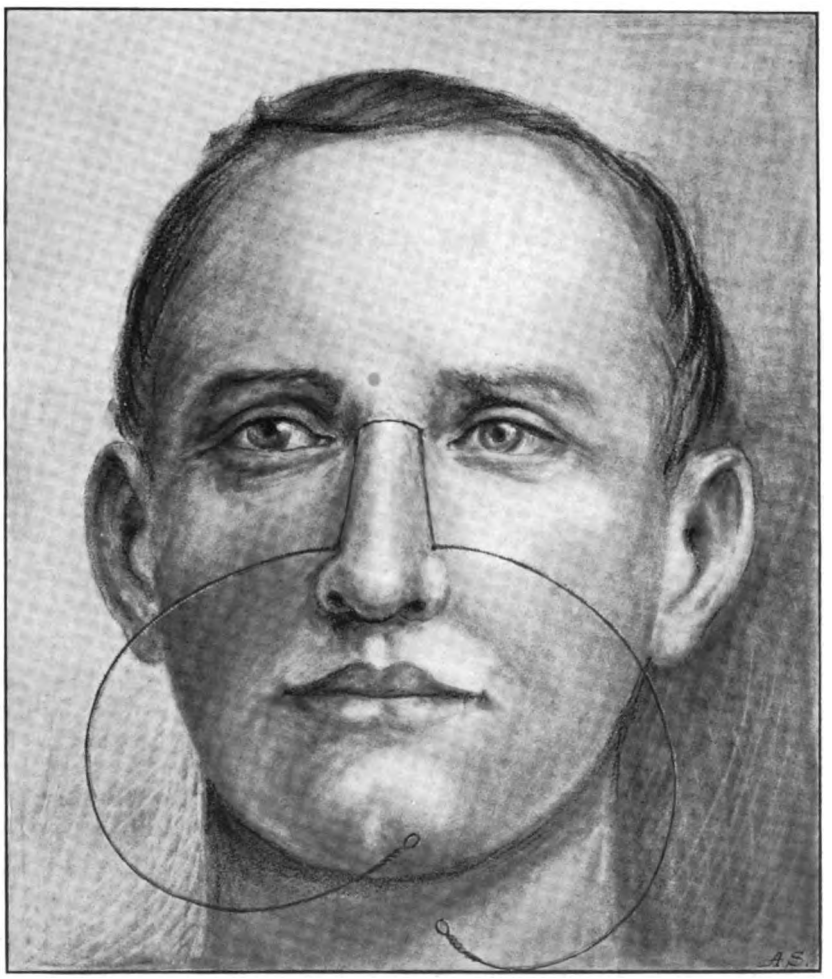
An anteroposterior section of the head shows that the roof of the nose, when compared to the parts situated anteriorly and posteriorly to it, corresponds, on the one hand, to the depression at the root of the nose, and, on the other, to the uppermost part of the sphenoidal sinus, the anterior wall of which slopes down posteriorly and forms the upper half of the posterior wall of the nasal cavity (Plate XXX). Hence, to expose the sphenoidal sinus, an incision at the root of the nose and from there downward is sufficient and renders opening of the frontal sinus unnecessary. The entire height and width of the interior of the nasal fossæ can be exposed by turning the nose downward. An incision is made on either side, starting below at the widest part of the bony nasal aperture (pyriform fossa) and passing upward to the depression at the root of the nose. These two incisions are united by a cross incision, the scalpel passing through all the tissues down to the bone (Plate XXXI). The periosteum of the osteoplastic flap is not interfered with, but that lying opposite is pushed backward toward the face only enough to accommodate the width of a Gigli saw, which is now used, beginning with a cut at the root of the nose to form a groove (which will fix the saw for its downward course) and then continuing through the bone freed of its periosteum until the lower end of the incision has been reached. A retractor, grasping the flap above and drawing it forward, will open a cleft into which a scalpel can be introduced to complete the separation of the cartilage of the septum sufficiently to permit complete depression of the nose, thus exposing the full height and width of the nasal fossæ. The hinge of the soft part, which remains below, contains the terminal branches of the facial arteries, which will nourish the osteoplastic flap thus formed. With curved scissors directed along the roof of the nose, the septum can be severed superiorly and posteriorly along the sloping anterior wall of the sphenoidal sinus. In order to facilitate the grasping of the bleeding vessels, ½ centimeter of the septum should be left standing above while posteriorly it is cut close to the sinus wall. To expose this anterior wall of the sinus, straight scissors should now be used to cut the septum, from below and in front, upward and backward to the middle of the posterior wall of the nasal cavity. A wedge-shaped

PLATE XXX.



Anteroposterior section of head, showing incision line of nose and septum for exposing interior of nose. Also part of septum (wedge) to be removed for exposing sphenoidal sinus and pituitary gland.

PLATE XXXI



External line of incision, showing extent to which bones are divided by the Gigli saw.

section of septum is thus removed, producing a funnel-shaped cavity, the opening of which corresponds to the outer border of the nasal cavity and the smaller end to the anterior wall of the sphenoidal sinus, which must be removed. Only in the event of protruding middle turbinals and prominent lateral masses of ethmoid cells should these be interfered with. This is best done by cutting away the turbinals with straight scissors and removing the cell masses by means of a bone curette or forceps. A greater resistance present after ethmoid cells have been removed indicates the orbital plate. The same resistance is met at the roof of the nose and acts as a barrier, preventing exposure of the dura.

After the anterior wall of the sphenoidal sinus is removed by means of chisel and bone-cutting forceps, the prominence on the posterior wall becomes apparent. This prominence is the depression caused by the floor of the sella turcica, and that part of it corresponding to the median line of the skull must be removed to reach the pituitary gland. Oftentimes the septum between the sphenoidal sinuses is irregularly placed to one or other side of the median line of the skull, or starts on one side or other above and runs to the opposite side below; frequently it is entirely absent. Therefore, to expose the pituitary body, it is essential to choose the median line of the skull, not permitting the irregularly attached sphenoidal septum to detract from removal of the midportion of the prominence on the posterior wall of the sinus. This should be confined to the central portion to avoid injuring the cavernous sinuses and carotid arteries on either side, and a button about half a centimeter in diameter should be removed with a trephine or a long-handled gouge, its concave surface directed toward a central point. For a decompression operation to relieve the tension of a tumor, more of this posterior wall must be removed. After the bone corresponding to the floor of the sella turcica has been removed, the cavity is recognized by probing, the resistance of the posterior wall of the sella turcica (dorsum sellæ) indicating the exact location of the cavity sought for. Removal of the gland can be accomplished by means of a long-handled scoop or curette.

The purpose of the procedure having been accomplished, the nose is brought back into place and secured by several sutures for the deeper tissues and periosteum and finally some for the skin. In this way the greater part of the interior of the nasal cavity remains intact and the part sought for is completely exposed, illumination of the depth of the cavity being accomplished by means of a head light or an electric pencil directed to the field of operation.

V

POSTURAL TREATMENT OF OTITIS MEDIA AND MASTOIDITIS

V

POSTURAL TREATMENT OF OTITIS MEDIA AND MASTOIDITIS

During the past few years operative procedure has become so common in otology that with many surgeons the slightest sign of involvement of the mastoid antrum complicating an otitis media is considered an indication for operative interference. A better understanding of the anatomical relations of the parts, together with the application of one of the fundamental principles of successful surgery, that is, drainage, would lead to a more conservative line of treatment in a direction that seems to have been entirely overlooked, namely, the posture of a patient with otitis media or mastoiditis. The relationship of the middle ear and antrum is such that, if an inflammatory exudate is present in the middle ear and the patient is lying on his back, the secretions will flow by gravity from the middle ear through the aditus ad antrum to the mastoid antrum itself. The presence of a secretion will, of course, irritate the membrane lining the antrum and produce mastoiditis, even though the inflammation has not extended from the middle ear. Let us recall for a moment the exact relations of the parts in the tympanic cavity. (See Plate XXXII.)

Anteriorly is the opening of the Eustachian tube. It is through this tube that an inflammation originating in the nose or pharynx extends and causes an involvement of the middle ear. The mucous membrane lining the tube swells and clogs this channel temporarily. The natural passage through which the middle ear is aërated and drained is closed, and the result is a retention of the inflammatory secretions within the middle ear, which aggravates the already inflamed membrane. If not relieved there is in time a bulging of the tympanic membrane accompanied by great pain, and if a paracentesis is not performed an extension to attic, aditus, and antrum occurs. If the drainage through the perforation is sufficient, the process of repair sets in and frequently the inflammation of the entire tract subsides, even though it has extended to the attic, aditus, and antrum. If pus is present, there is an erosion of the membrane which, owing to interference of the circulation from pressure, has become less resistant, and a perforation results—which gives relief from the symptoms of pressure. As far as the middle ear is concerned, the tendency now is to repair. But what happens to the antrum if it has become filled with the exudate? As these cases are

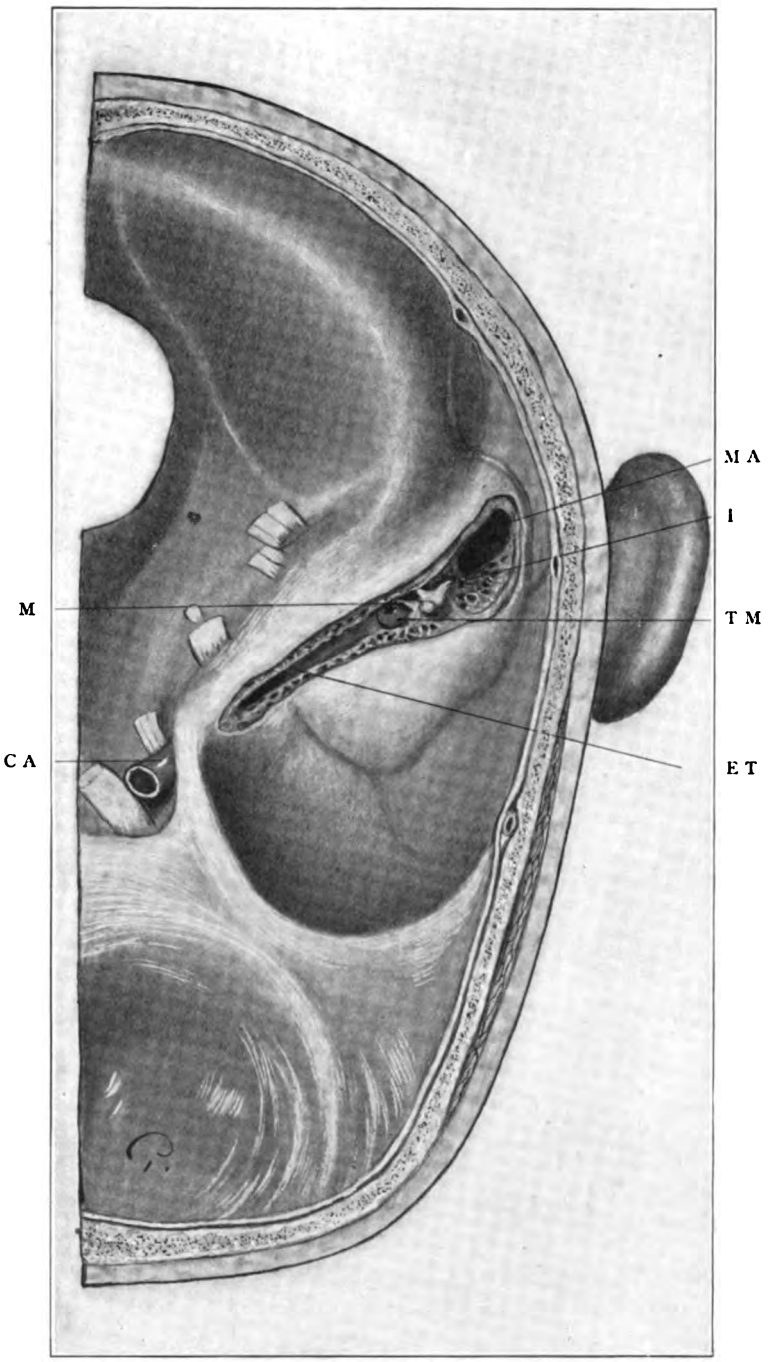
now ordinarily treated, the patient is permitted either to sit erect or lie on the back, or occasionally on his side. In the recumbent position the irritating discharge remains in the antrum and causes an inflammation which, in turn, adds to the exudate, of which only the overflow leaves the antrum through the aditus.

The inflamed membrane goes on to ulceration and eventually to necrosis of the bony lining, with further involvement of efferent veins and lymph channels, infecting all the important surrounding structures and thus establishing the various complications of middle ear disease. If the mastoid process is cancellous, the extension of the inflammation to other pneumatic cells throughout the process may be very rapid. Necrosis extending backward from the antrum soon reaches the bony lining of the lateral sinus, or the inflammation may extend through the connecting veins of the sinus, producing a thrombosis of the lateral sinus, without antecedent necrosis.

Referring again to the anatomical relations, we have externally the drum membrane; internally, the bony inner wall, with exception of the membrane of the round window; above, the ossicles and the bony roof; posteriorly, a bony wall below and an opening above, that is, the aditus or passage which leads to the antrum. The position of this passage high up on the posterior wall undoubtedly in many cases prevents the inflammatory process from reaching the antrum. On the other hand, when the antrum is once involved and the patient is allowed to rest on his back, the position of the aditus in its relation to the antrum is such that the acrid secretions are prevented from leaving the latter, and thus is produced all the trouble we are familiar with. What then can be done to relieve this apparent faulty provision of nature when inflammation ensues? This apparently faulty provision of nature is really an excellent one and finds its parallel in the accessory sinuses of the nose.

The ostia of the maxillary, frontal, and sphenoidal sinuses also are at the highest point possible and well protected, so that no extraneous matter from the inhaled air can enter and infect them. When, however, inflammation occurs, the ostia are most unfavorably situated for draining the cavities, and if relief is not given by posture they must be opened at the most dependent point. This question of drainage is the all-important factor in the successful management of these cases, and the anatomical relations point out the proper course to pursue. If the middle ear or antrum is to be drained, the patient should be placed in such a position that it will drain. And what is this position? *It is one in which the antrum is placed at a higher elevation*

PLATE XXXII



Base of the skull seen from above with the dura mater intact, except over a portion of the temporal bone where it and the bone have been cut away to expose the Eustachian tube, the tympanic cavity, the attic, aditus ad antrum, and the mastoid antrum.

M, Long process of malleus.
C A, Carotid artery.
M A, Mastoid antrum.
I, Short process of the incus.
T M, Tympanic membrane, with perforation.
E T, Eustachian tube.

than the middle ear, and the middle ear higher than the Eustachian tube, its natural outlet or drain. With a patient lying face downward—the forehead and one cheek supported by pillows, the nose and mouth and one eye free—perfect drainage can be procured. When the patient is made to realize the importance and advantages of this position, he will not only assume it from necessity, but even adopt it by preference as a comfortable posture during sleep. Now, what happens in this posture?

If an otitis media alone exists, the secretion will drain through the Eustachian tube, provided it is not clogged, or through a perforation of the drum membrane, if such exists. This would prevent antrum involvement, which might have occurred if the secretion had been allowed to flow into it and be retained there. If the antrum is already inflamed, the secretion, flowing off through the aditus into the middle ear and out as before, will enable the mucous membrane lining it to proceed to repair, and erosion of it and necrosis of the underlying bone will not occur. Even though the external symptoms of pain on pressure and edema over the mastoid process have occurred, generally these will gradually subside and disappear, and an operation with a tedious and painful after-treatment will become unnecessary.

The management of otitis media or mastoiditis is, therefore, as follows:

A purgative is given to aid in relieving the local congestion in the affected area. The rhinitis or pharyngitis, whichever may have been the causative factor in the involvement of the Eustachian tube, receives the utmost attention, the greatest efforts being directed to the Eustachian opening and nasopharynx. Following this, the tube itself is treated in order to reduce the swelling of its lining membrane, to render it patent, and thus effectually to drain the middle ear. The patient is directed to produce suction in the Eustachian tube by swallowing water, with the nose and mouth closed, several times daily. If these measures do not suffice to relieve the condition in the middle ear without operative procedure, paracentesis of the drum membrane should be performed. Instead of the ordinary puncture of the membrane, I incise it from its midpoint (tip of long process of malleus) downward, and make a second incision posteriorly, beginning half-way up and curving downward and forward until the second and first incisions meet, thus forming a flap. This gives a larger opening than a single incision, and, besides permitting free draining, is large enough for introducing a small cannula for irrigating the middle ear. In douching the tympanic cavity in mastoiditis the stream should be directed upward and backward toward the aditus. The patient is advised to lie face downward most of the time, and

occasionally upon the affected side. The Eustachian tube should be treated through the nose by means of a catheter, through which a mild antiseptic and detergent solution may be introduced; this flows out through the perforation in the drum. On the other hand, if in irrigating the tympanic cavity the Eustachian tube is patent, the solution will flow out of the nose or into the throat. For irrigating through a perforation, a thin cannula, bent at the end and attached to a rubber bulb placed at an angle permitting exact introduction by sight, should be used. The irrigations are performed by the attending physician twice daily or at longer intervals according to the stage of the process. This frees the middle ear, the aditus, and the Eustachian tube, and as soon as the secretions have diminished and drainage is sufficient through the Eustachian tube, the flap made in the drum may be allowed to fall back into place and to close the perforation, forming a perfect membrane instead of the large perforations that are liable to result from other incisions. The patient himself douches the outer ear at more frequent intervals, and retains the prone posture for the greater part of the time between treatment. Before douching, the patient is instructed to introduce a detergent and cleansing solution full strength into the outer ear to be retained for from five to ten minutes while lying on the other side.

Adrenalin, alcohol, powders, or other medicaments may be used as indicated, to hasten the process of repair. I am also in the habit of having patients take one-half gallon of some alkaline water during the twenty-four hours, as I believe it thins the discharge, causes it to flow off more rapidly, and prevents accumulation and formation of crusts.

In several instances of severe otitis media and mastoiditis, in which, in the opinion of eminent otologists, it was deemed necessary to operate immediately, I have been able by this more conservative treatment to cure the condition present; and I feel that by this simple method, I have prevented many cases of otitis media from developing into operable mastoiditis. Of the measures used the postural treatment was probably the most essential.

VI

A CONTRIBUTION TO THE ANATOMY AND SURGERY OF THE TEMPORAL BONE

VI

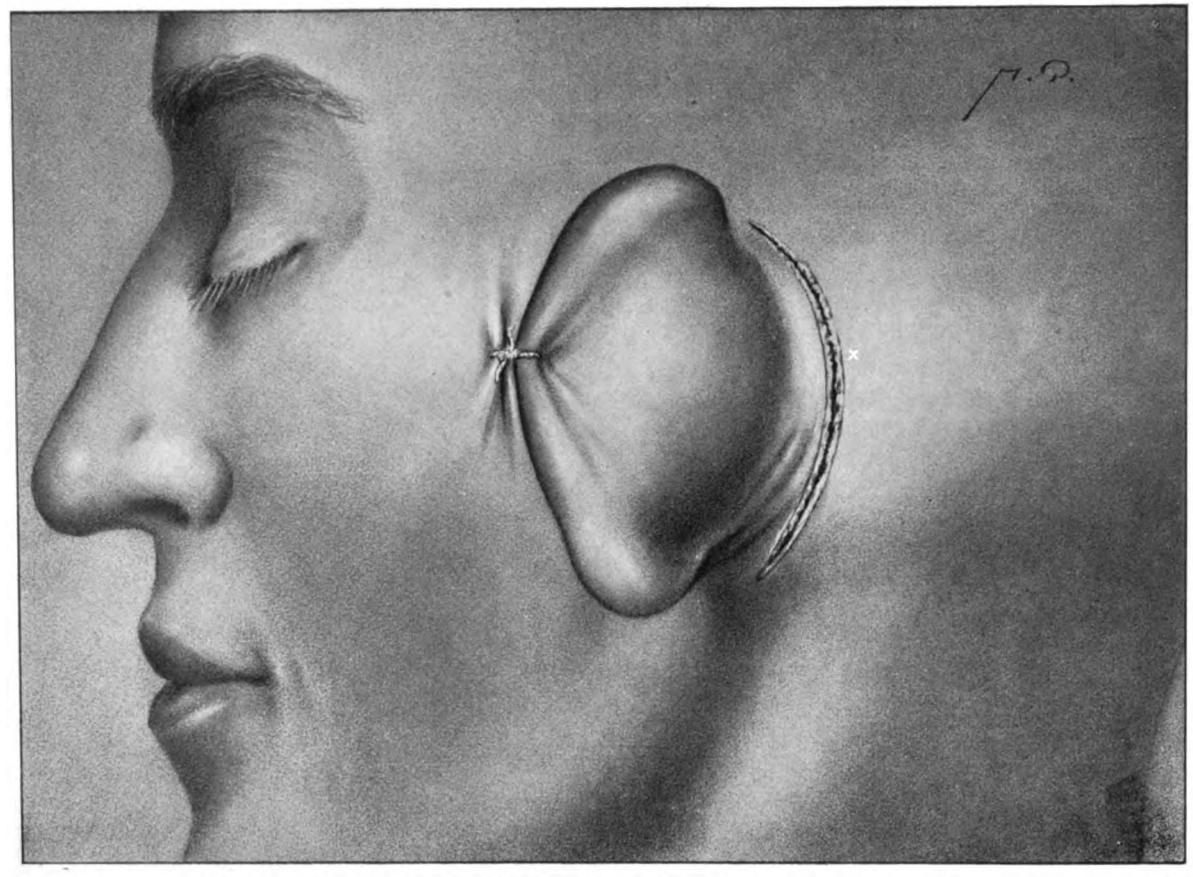
A CONTRIBUTION TO THE ANATOMY AND SURGERY OF THE TEMPORAL BONE

The recent additions to the symptomatology and diagnosis of complications and sequelæ of middle-ear disease, with the resulting surgical interference in deep-seated affections, have made it necessary to acquire a more intimate knowledge of the landmarks of the ear and its surrounding structures. The present article, with the accompanying charts drawn from dissections on the cadaver, is intended to fill a requirement still existing in our medical literature and to serve as a guide for improved technique in the future for attacking the temporal bone and vital parts in its immediate neighborhood.

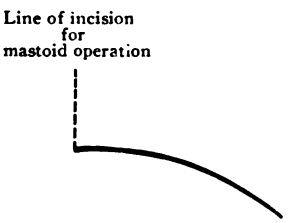
In the comparatively simple procedure of entering the mastoid antrum an incision through the skin, fascia, and periosteum, beginning behind the attachment of the auricle, at a point corresponding to the upper wall of the external auditory meatus and passing over the middle of the mastoid process to its tip, will suffice, if the tissues are drawn forward, to expose sufficient bone to appreciate the landmarks necessary for this operation. In the more extensive procedure of attacking the middle ear and its adjacent parts, a longer incision is necessary. The incision begins at a point above the ear sufficiently far back to avoid the temporal artery, then courses downward ½ to 1 cm. behind the attachment of the auricle, in order to avoid severing the posterior auricular artery, and ends at the tip of the mastoid process (Plate XXXIII).

When the tissues are dissected and retracted a field will be exposed in which the entire outer and middle ear, as well as the mastoid antrum and the sigmoid flexure of the lateral sinus, can be reached (Plate XXXIV). Above the temporal ridge this incision should pass through skin alone, exposing the temporal fascia covering the temporal muscle; this should not be severed. Below the ridge it should pass directly to the bone of the mastoid process. The anterior flap should contain the auricle with the periosteum from the mastoid process and the entire soft parts of the external auditory meatus, the periosteum of the meatus remaining continuous with that covering the mastoid process. On elevating the periosteum and retracting the tissues still covering the process behind, an area will be exposed suf-

PLATE XXXIII



Line of incision for radical operations. × Point from which incision for "mastoid operation" is made.



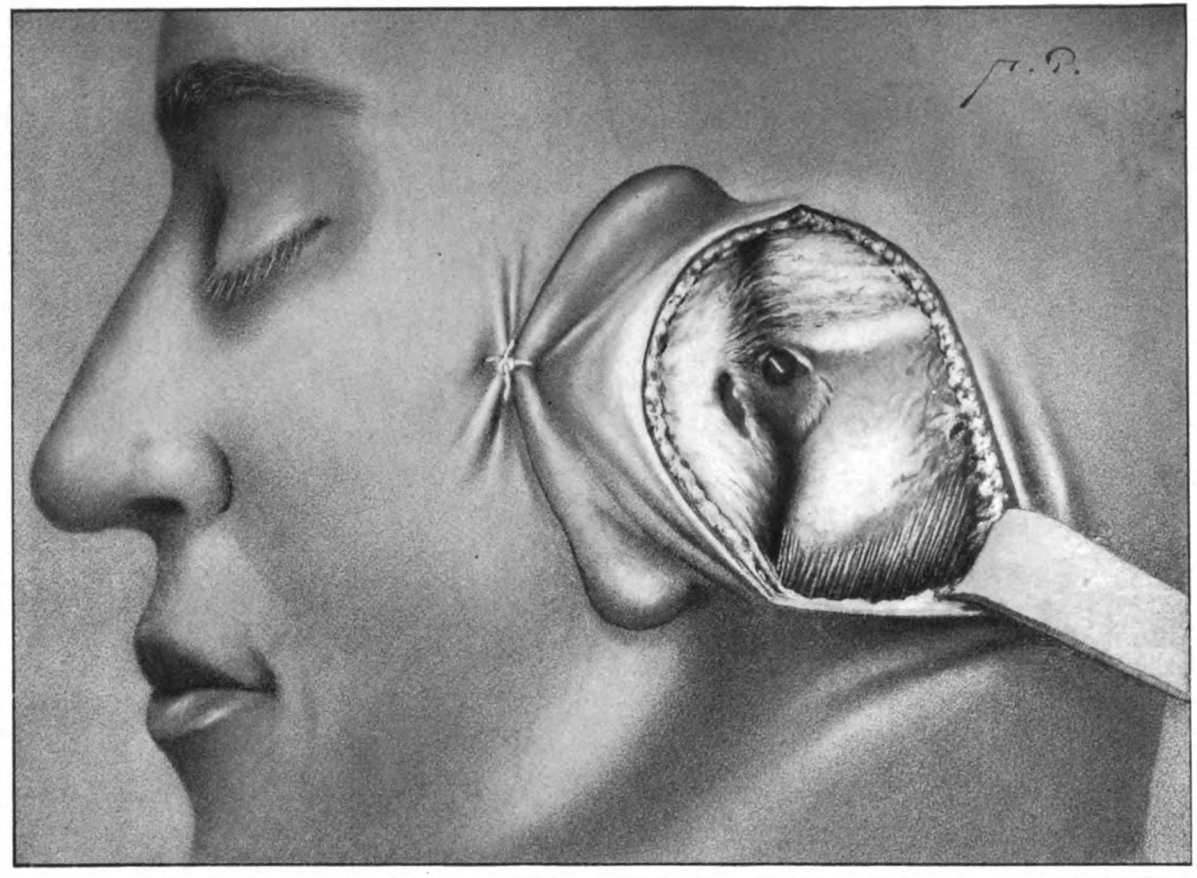
ficient for the most radical operation on the temporal bone, even to the extent of its entire removal.

The following are the landmarks visible from above downward (Plate XXXIV). Above the temporal ridge or crest is the fascia covering the temporal muscle. The crest is the continuation backward of the zygomatic arch and affords attachment to the fascia as well as the temporal muscle, and corresponds in height to the upper wall of the bony auditory canal; it forms the division line between the squamous and mastoid portions of the temporal bone, and serves as a landmark for opening the mastoid antrum and lateral sinus.

In a simple mastoid operation the external opening should remain below this crest in order to avoid entering the cerebral cavity.

Below the crest and in front of the mastoid process is seen the external auditory meatus, a long, funnel-shaped canal, the walls of which are formed

PLATE XXXIV



Tissues exposed with incision as indicated on Plate XXXIII, showing tympanic membrane with manubrium of malleus, tympanic plate, with auricular process, and suprameatic spine. Behind the meatus the temporal fascia, temporal ridge, mastoid process, mastoid foramen, and sternocleidomastoid muscle.

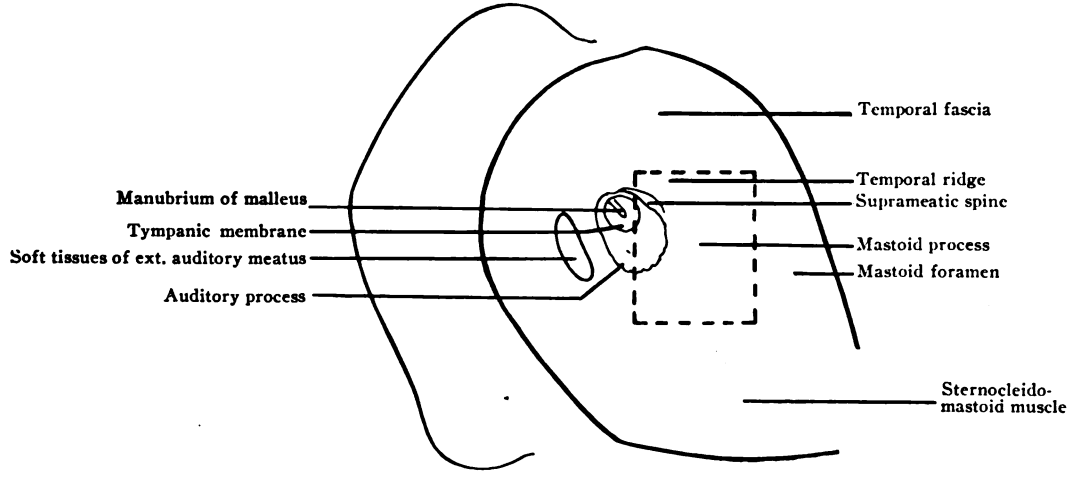
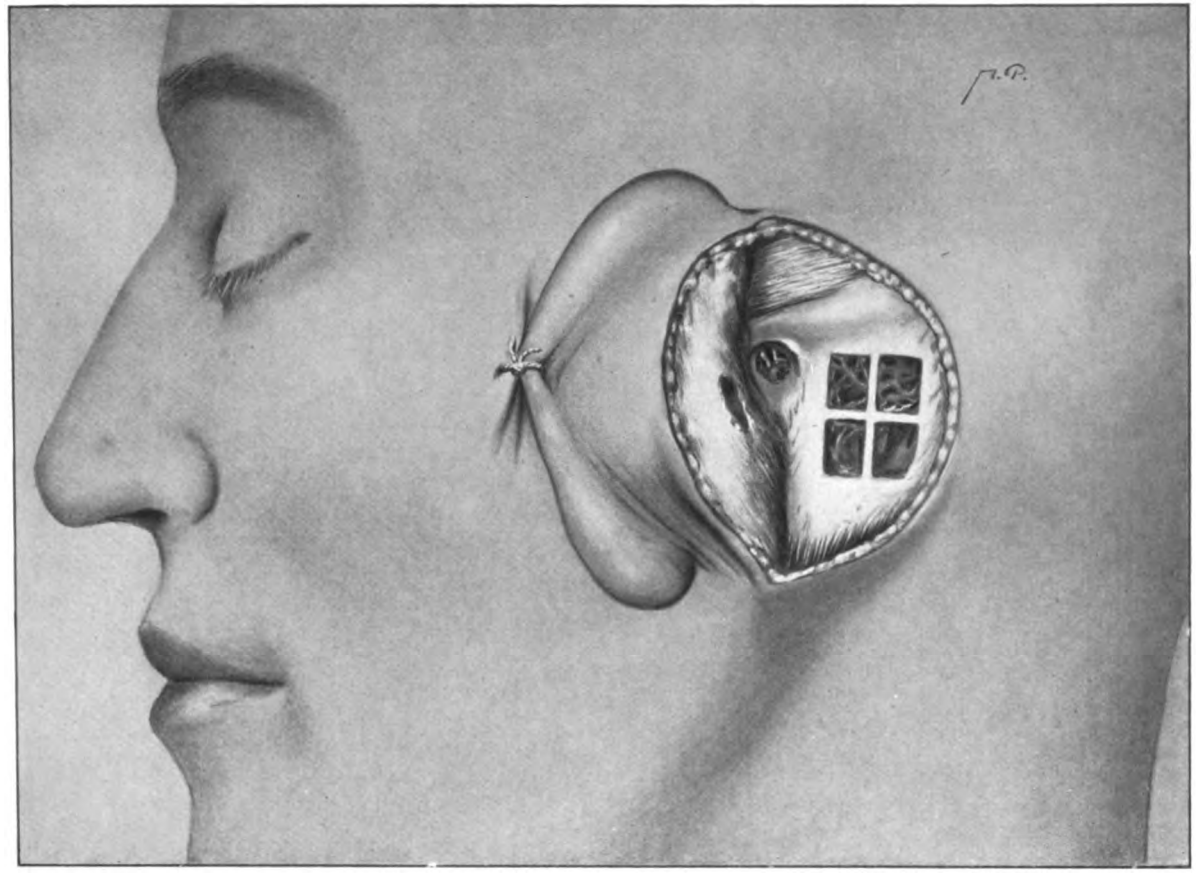

Temporal fascia
Temporal ridge
Suprameatic spine
Manubrium of malleus
Tympanic membrane
Soft tissues of ext. auditory meatus
Auditory process
Mastoid process
Mastoid foramen
Sternocleido-
mastoid muscle

PLATE XXXV



Exposure of middle ear after removal of tympanic membrane, showing manubrium of malleus, processus longus of incus, promontorium, and fenestrum rotundum. Also pneumatic cells in "mastoid quadrants."

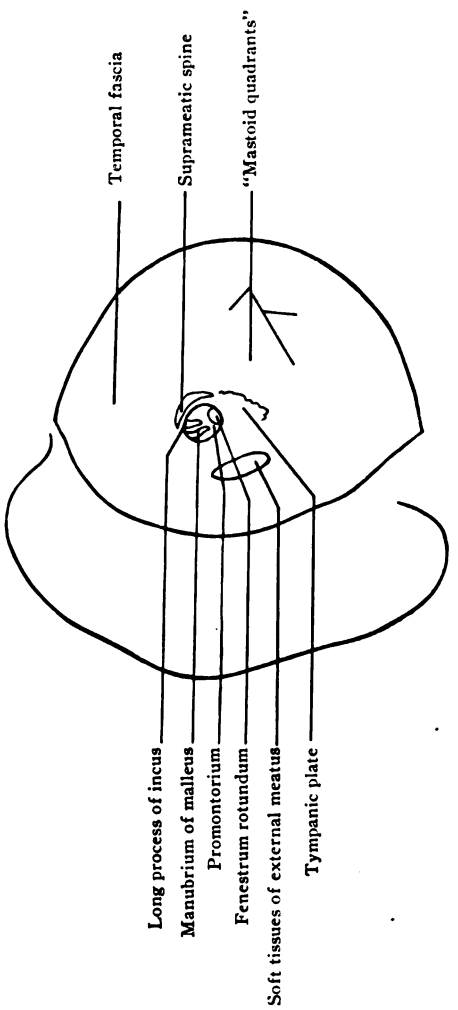
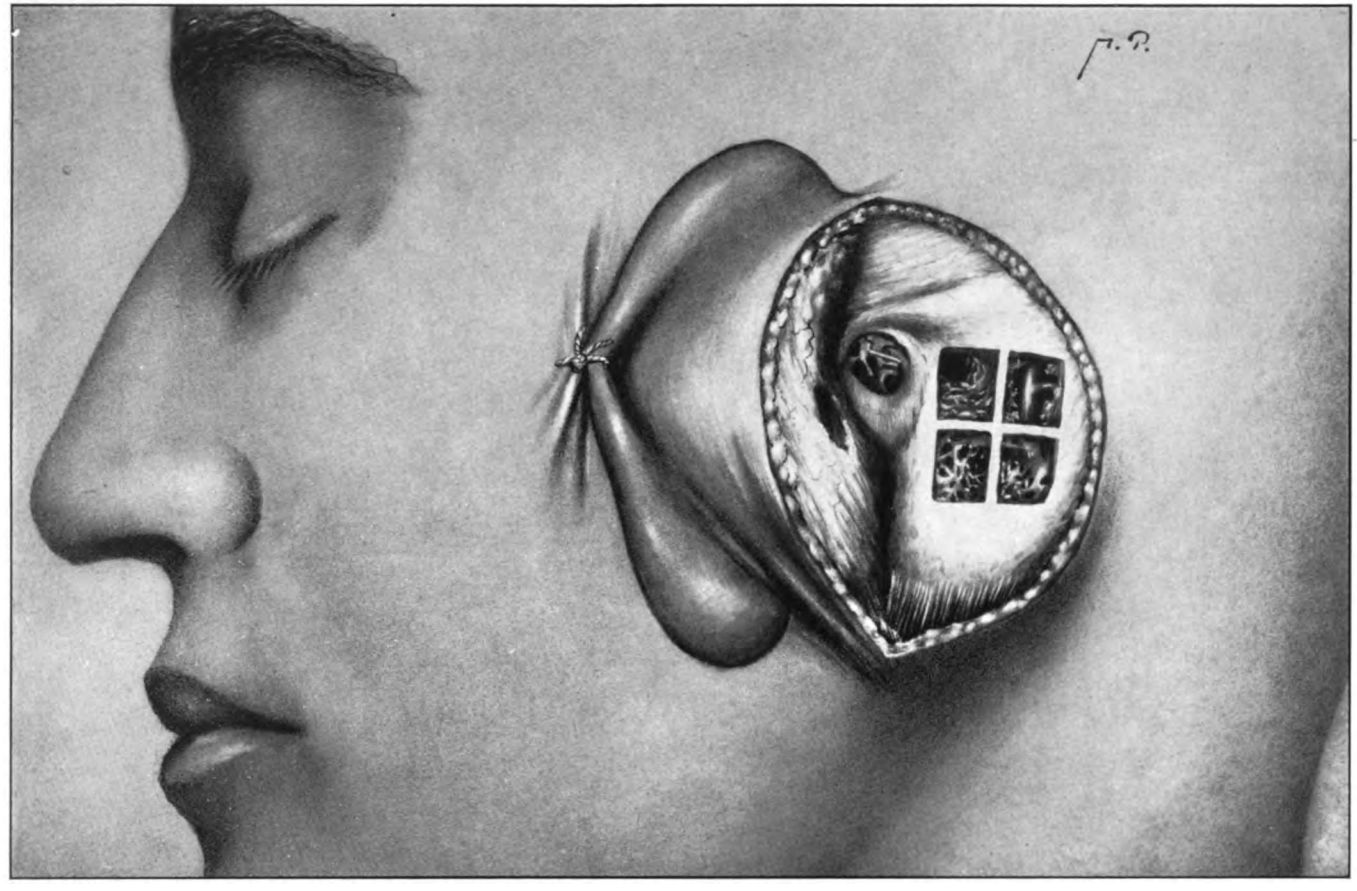
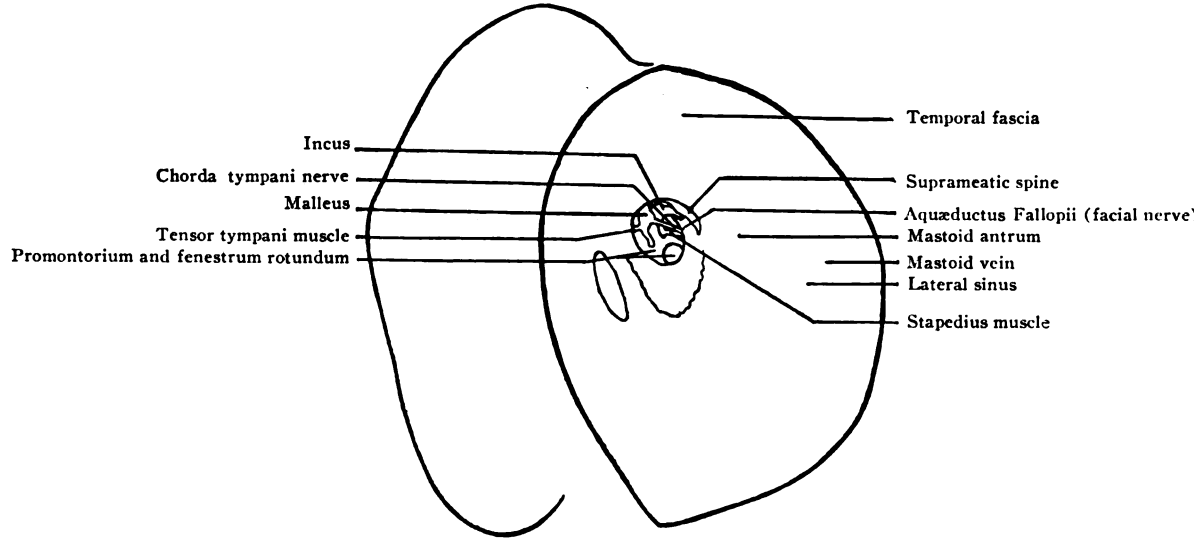

Temporal fascia
Suprameatic spine
"Mastoid quadrants"
Long process of incus
Manubrium of malleus
Promontorium
Fenestrum rotundum
Soft tissues of external meatus
Tympanic plate

PLATE XXXVI



Portion of upper and posterior walls of external bony meatus removed, showing tensor tympani muscle attached to malleus anteriorly; chorda tympani nerve emerging from aquæductus Fallopii, posteriorly, crossing incus; below this the stapedius muscle, promontorium and fenestrum rotundum. The upper anterior quadrant shows the mastoid antrum; the upper posterior, the lateral sinus with mastoid vein; the two lower quadrants, mastoid cells.


Incus
Chorda tympani nerve
Malleus
Tensor tympani muscle
Promontorium and fenestrum rotundum
Temporal fascia
Suprameatic spine
Aquæductus Fallopii (facial nerve)
Mastoid antrum
Mastoid vein
Lateral sinus
Stapedius muscle

by the tympanic plate. The free margin of this plate (the auditory process) affords attachment to the cartilage of the ear.

In the depth of the meatus is seen the tympanic membrane or ear drum, lodged in a ring of bone with the manubrium or handle of the malleus, attached to and shining through its upper half, slanting from above and in front downward and backward. The upper portion of the membrane is thrown into folds by the outward projection of the processus brevis of the malleus, which springs from the upper part of the manubrium close to the tympanic ring. The portion of the membrane thus affected is called Shrapnell's membrane.

On removing the tympanic membrane from its ring of bone and from its attachment to the malleus, the tympanic cavity or middle ear is exposed and the following points of interest noted (Plate XXXV): In the upper half of the cavity are seen anteriorly the manubrium, projecting downward and slightly backward, with the processus brevis at its upper end close to the rim of the bony canal. The processus longus of the incus is situated half a millimeter behind and parallel to the manubrium, and has its lower end attached to the stapes. The lower half of the cavity presents a rounded, glistening eminence, called the promontorium, and an opening directly behind it called the fenestrum rotundum. The latter opens into the cochlea, of which the promontorium represents the first turn.

In order to expose the tympanic cavity or middle ear more thoroughly, a part of the superior and posterior walls of the external meatus can be removed (Plate XXXVI). The tympanic cavity (as seen in the last plate) has its upper part, the attic, hidden behind the inner portion of the upper wall of the external auditory meatus. Hence, the upper wall of the meatus corresponds to the outer wall of the attic, and with the procedure just mentioned the attic is exposed.

The attic contains the heads and bodies of the malleus and incus, and the removal of its outer wall shows these bones *in toto*. Besides these structures the tensor tympani muscle can be seen anteriorly emerging from its canal and becoming inserted into the neck of the malleus. The short process of the incus is seen projecting back into the aditus, while the long process descends to become attached to the stapes. Beneath the short process of the incus the chorda tympani nerve emerges from the facial canal in the posterior wall. It crosses the long process of the incus and disappears behind the malleus. When this nerve is injured accidentally or otherwise, the sense of taste for the corresponding side of the tongue is lost. Directly internal

to the tip of the long process of the incus lies the stapes placed at right angles to it. To the neck of the latter is attached the stapedius muscle, which consists of minute fibers 1 to 2 mm. in length coming from the pyramidal-shaped cavity in the posterior wall of the tympanum. In the background, portions of the inner wall of the middle ear are visible. Directly above the stapes and behind the incus is the projection of bone covering the facial nerve. Below the stapes, the promontorium and fenestrum rotundum are again seen as before.

At the upper posterior angle of the entrance to the bony meatus is a spicule of bone known as the suprameatic spine (Plates XXXIV to XXXVII). This is of importance in the simple mastoid operation, as it is prominent in most skulls, and when felt, serves as a landmark, being the most anterior point to which the tissues should be dissected, and also the point 1 cm. behind which the opening for entering the antrum should be begun. The mastoid process (Plate XXXIV), of which the temporal ridge forms the base line, has been denuded of periosteum. Near its posterior border is situated the mastoid foramen, through which one of the emissary veins of the lateral sinus passes. Below, the process has the sternocleidomastoid muscle attached to it. The fibers of this should be left intact when these parts are exposed, excepting in those instances in which their presence interferes with the thorough exploration of the mastoid cells.

The nature of the bony structure of the process varies greatly in different subjects, being very compact tissue (small celled or diploic) in some and cellular (large celled or pneumatic) in others.

To reach the antrum, the chisel or burr drill must be placed at a point 1 cm. behind the suprameatic spine, and keeping below the temporal crest, or the upper wall of the meatus, must penetrate a mass of bony tissue to a depth varying from 1 cm. to 2 cm. in a direction inward, forward, and slightly upward, corresponding to the direction of the external auditory canal. The position of the antrum varies somewhat. Although it is generally situated about ½ to 1 cm. behind the outer opening of the auditory canal, it is sometimes found almost directly internal to its upper wall. The depth at which the antrum is met also varies, but it is safe to say that if the instrument penetrates deeper than 1½ cm., and be directed too far forward or downward, the horizontal simecircular canal or the aquæductus Fallopii will be encountered (Fig. XXXIX). If the former were opened in a purulent otitis media the pus would travel along it to the vestibule and from there into the internal auditory meatus, producing a pachymeningitis or ex-

tradural (epidural) abscess of the posterior fossa of the skull; or from the vestibule through the perpendicular semicircular canal, which if accompanied by erosion of its bony covering would lead to involvement of the meninges of the middle fossa. The same would hold good for the posterior semicircular canal affecting the posterior fossa.

If the latter (the aquæductus Fallopii) were opened an inflammation of the facial nerve which is contained therein would result, producing paralysis of that side of the face. The inflammatory process might also find its way through the entire canal to the internal auditory meatus, causing a pachymeningitis or extradural abscess as mentioned above; or, traveling along the nerve to its cerebral attachment, would produce a meningitis or subdural (intradural) abscess. The direction of the penetrating instrument must also be forward, in order to avoid injuring the lateral sinus.

For extensive dissections on the mastoid process, where involvement of the antrum as well as the lateral sinus and the mastoid cells is suspected, a division of the process into four equal parts suggested itself to Dr. Hartley, and the following procedure has been evolved * (Plates XXXV, XXXVI, and XXXVII): The temporal ridge, or a line continuous with the zygomatic arch, is taken as the upper boundary; the anterior border of the mastoid process, as the anterior boundary; a line drawn vertically from the junction of the posterior border of the mastoid process where it meets the occiput, as the posterior boundary; and an imaginary line drawn backward from the tip of the mastoid process, as the lower boundary of a quadrangle. On dividing this into four equal parts it was found that in almost every instance the upper anterior quadrant opened into the mastoid antrum, the upper posterior quadrant opened into the lateral sinus, and the two lower quadrants into mastoid cells. The lower posterior quadrant also opens into the descending limb of the lateral sinus if gone into sufficiently deep.

In permitting a wall of bone to remain separating the anterior and posterior quadrants, a safeguard is established which prevents the infectious discharge which might be found in the anterior quadrant (antrum), entering and setting up a similar process in the posterior quadrant with its lateral sinus, providing this has been exposed and found to be healthy and patent.

In this way, if any doubt exists as to the extent of infection, the entire surface of the mastoid can be immediately mapped out, and the upper an-

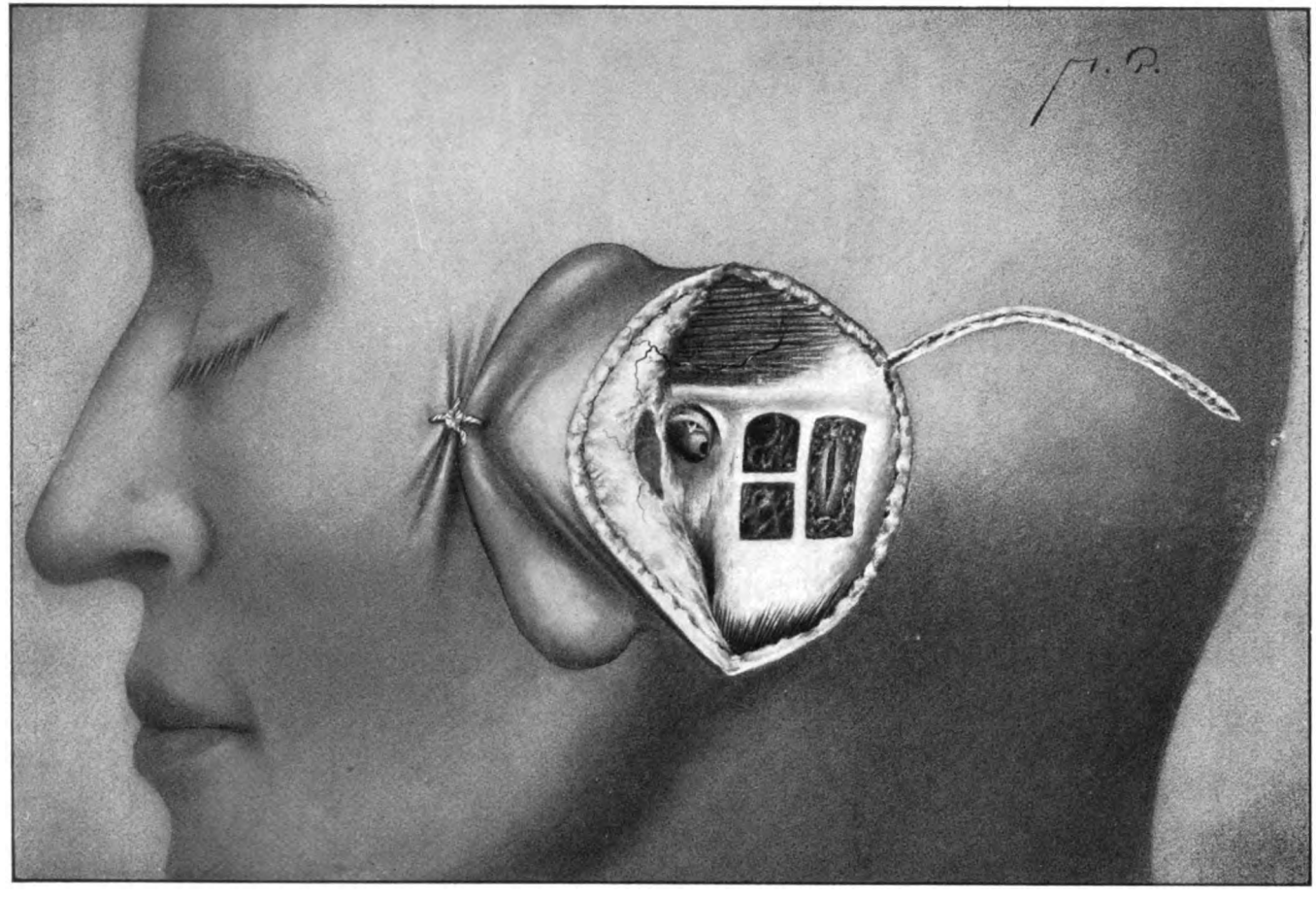
* In Chipault's *Surgery* reference is made to the division of the mastoid process for the purpose of locating the lateral sinus.

terior quadrant opened first to determine if the antrum is involved (Plate XXXVI). If this be so and the mastoid cells themselves contain pus, one or both lower quadrants can be opened and evacuated. If the process is very extensive, and there is reason to suspect an infected thrombus in the descending limb of the sigmoid flexure of the lateral sinus, which is the most frequent site for a beginning thrombus, the upper posterior quadrant can be gone into, the sinus punctured with a hypodermic needle or incised, if sufficiently exposed, and the nature of its contents determined. The bridges of bone between the quadrants have the advantage over a continuous bony wound, made by chiseling off the entire outer surface of the mastoid, as performed by many surgeons, on account of the support given the tissues which preserve the original contour of the parts, and the barriers which they form between infected and non-infected areas.

The descending limb of the lateral sinus is met at a depth ranging from ½ to 1 cm., and is usually seen taking a somewhat slanting course from above and behind, down and forward; it then dips in forming the sigmoid flexure. The sinus generally fills the upper posterior quadrant, but at times it will be seen only in the posterior half or two-thirds of the quadrant, and in these cases the quadrant can be enlarged posteriorly. Frequently the mastoid vein can be seen entering the sinus at this point (Plate XXXVI). This vein is of importance in case of periostitis of the mastoid process, as the inflammation of its walls and its extension inward may be the origin of a thrombus of the lateral sinus; and in cases where the thrombus of the sinus already exists, the blood which is dammed up in the mastoid vein produces edema of the tissues which it drains, and becomes of diagnostic importance in determining the former condition.

On returning to the description of the middle ear we find that by severing the tensor tympani muscle in front, and the articular attachment of the incus below, both the malleus and incus can be removed, leaving the stapes *in situ* (Plate XXXVII). On removal of these two ossicles, the entire inner wall of the tympanum can be seen. The upper part, which also forms the inner wall of the attic, consists of a rounded projection, formed by the horizontal semicircular canal above and a lighter strip below, made up of a thinner plate of bone covering the facial nerve and forming the aquæductus Fallopii. The aquæductus Fallopii extends farther forward than the semicircular canal to the anterior and uppermost angle of the tympanic cavity. Below this projection the stapes is seen lodged in the fenestrum ovale, with the stapedius muscle, coming from behind, inserted into its neck. The

PLATE XXXVII



The malleus, incus, and chorda tympani nerve removed from middle ear, showing projection formed by external semicircular canal and aquæductus Fallopii; stapes in fenestrum ovale with stapedius muscle attached posteriorly. Ledge removed between posterior quadrants exposing descending limb of lateral sinus (sigmoid flexure), which is incised. Incision from upper posterior quadrant backward for exposure of horizontal limb of lateral sinus.

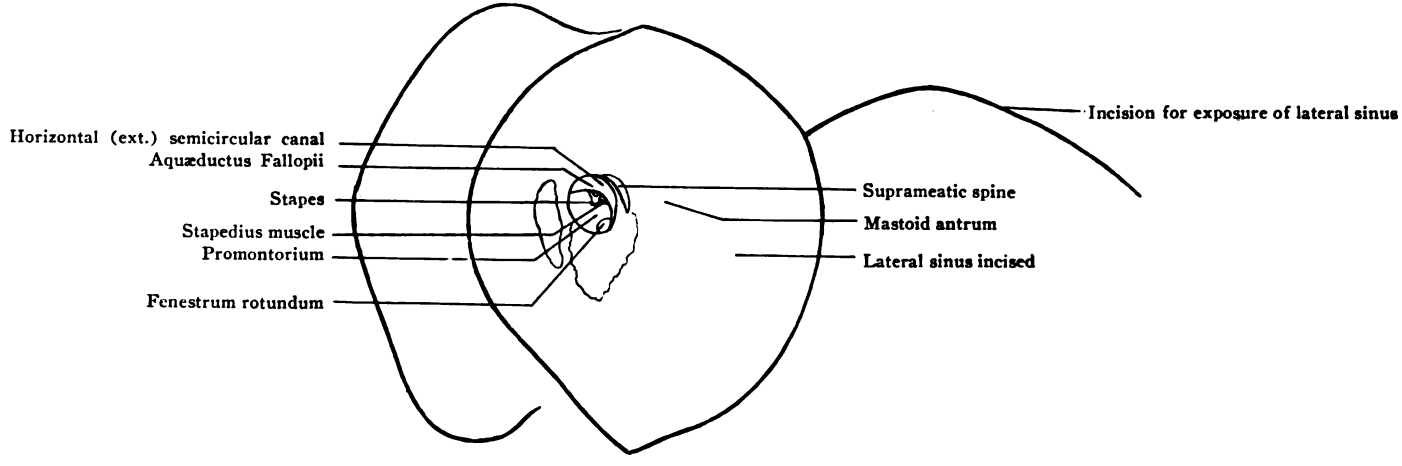
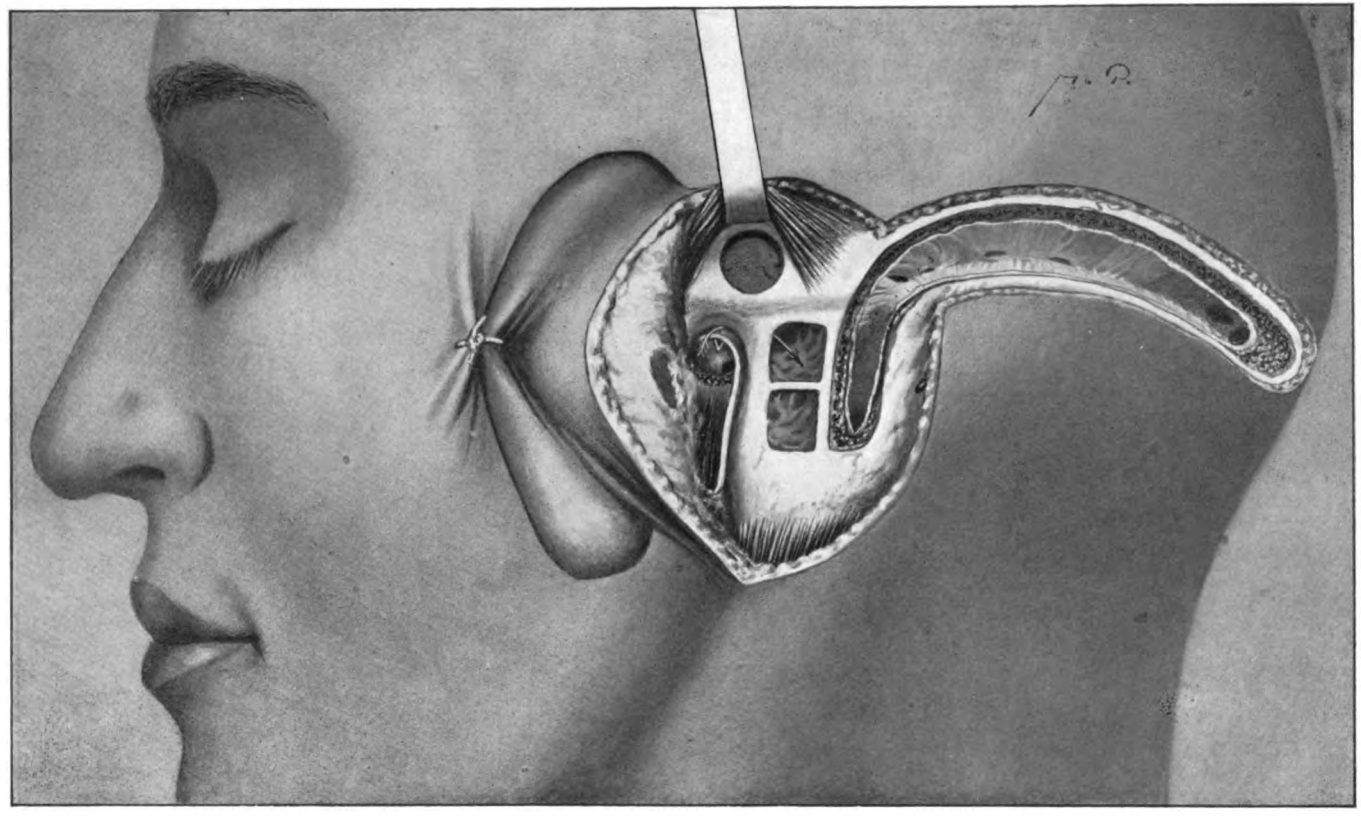

Horizontal (ext.) semicircular canal
Aquæductus Fallopii
Stapes
Stapedius muscle
Promontorium
Fenestrum rotundum
Incision for exposure of lateral sinus
Suprameatic spine
Mastoid antrum
Lateral sinus incised

PLATE XXXVIII



Outer wall of aquæductus Fallopii and the tympanic plate has been removed, exposing the facial nerve. Arrow in aditus ad antrum. Interior of entire lateral sinus exposed, showing slit for superior petrosal sinus anteriorly and openings for longitudinal and right lateral sinus posteriorly. Trephine opening in squamous plate, with middle meningeal artery showing.

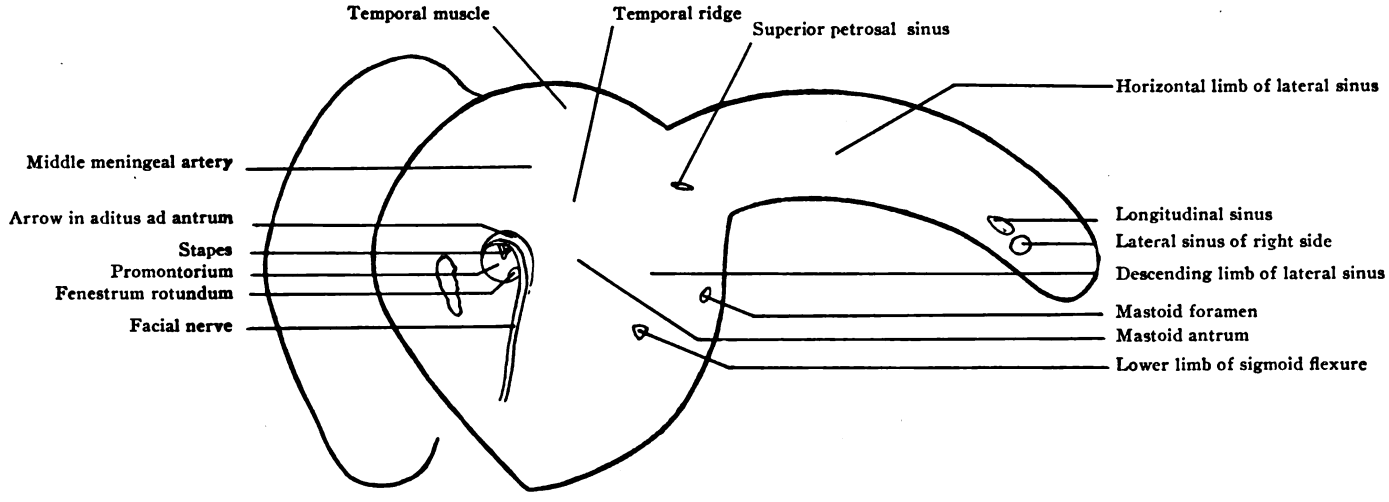
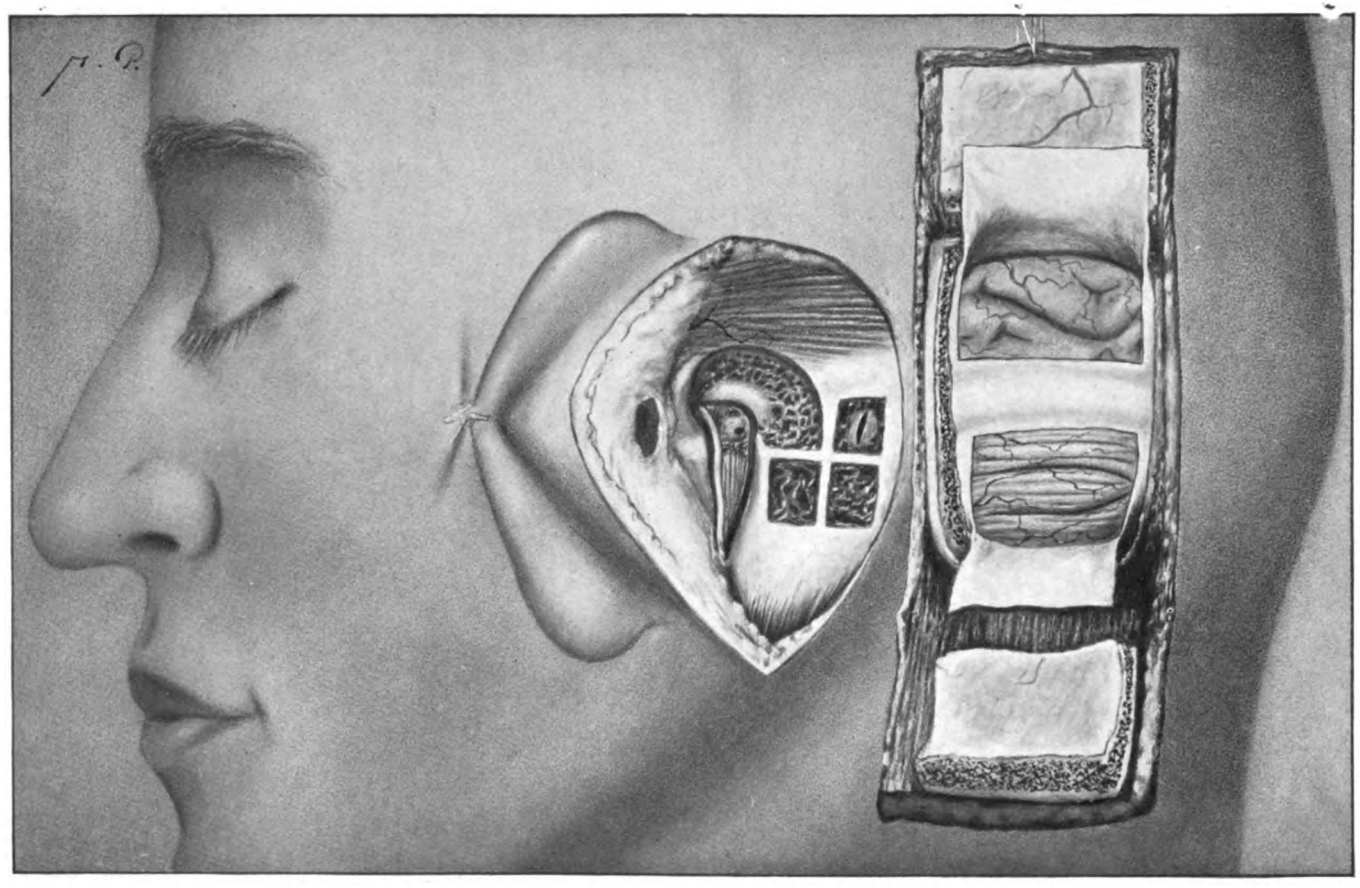
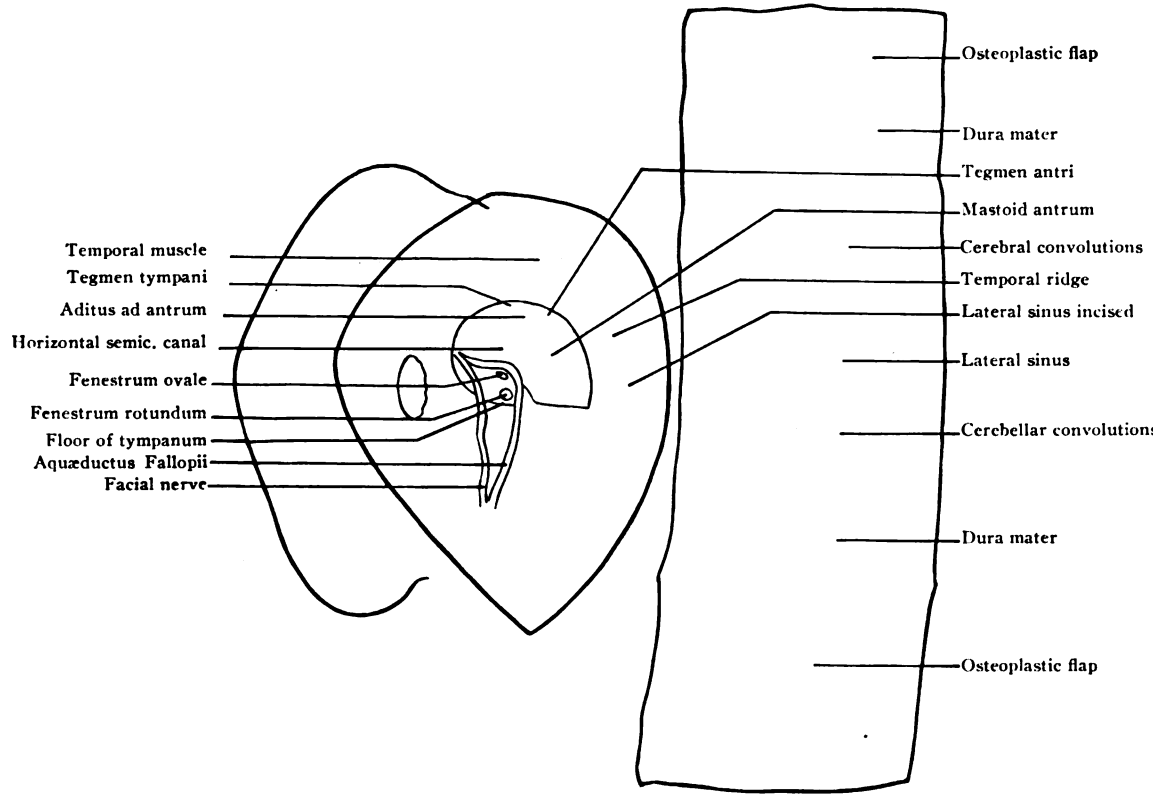

Temporal muscle
Temporal ridge
Superior petrosal sinus
Horizontal limb of lateral sinus
Middle meningeal artery
Arrow in aditus ad antrum
Stapes
Promontorium
Fenestrum rotundum
Facial nerve
Longitudinal sinus
Lateral sinus of right side
Descending limb of lateral sinus
Mastoid foramen
Mastoid antrum
Lower limb of sigmoid flexure

PLATE XXXIX



Bone of external meatus and outer wall of aditus ad antrum chiseled away, exposing the tegmen tympani, tegmen antri, atticus, aditus ad antrum, mastoid antrum, and external semicircular canal. The facial nerve is dislodged from the aquæductus Fallopii, and the fenestra ovale and rotundum appear below. Posteriorly two osteoplastic flaps, with horizontal limb of lateral sinus chosen as median line for exposing cerebral and cerebellar convolutions.


Temporal muscle
Tegmen tympani
Aditus ad antrum
Horizontal semic. canal
Fenestrum ovale
Fenestrum rotundum
Floor of tympanum
Aquæductus Fallopii
Facial nerve
Osteoplastic flap
Dura mater
Tegmen antri
Mastoid antrum
Cerebral convolutions
Temporal ridge
Lateral sinus incised
Lateral sinus
Cerebellar convolutions
Dura mater
Osteoplastic flap

promontory and fenestrum rotundum forming the lower half of the inner wall are seen to better advantage. The chorda tympani nerve has been removed.

To effect a more thorough and immediate exposure of the entire middle ear, when radical measures are intended, the removal with a chisel of the tympanic plate as far as the styloid process, in combination with the removal of part of the upper and posterior walls of the external auditory canal, will be found of the greatest advantage as a preliminary step (Plate XXXVIII). By removal of this plate of bone and the superficial lamina of the anterior surface of the mastoid process the entire facial nerve can be exposed and located and followed to the bend in the nerve at the upper anterior angle of the tympanic cavity. The nerve is lodged at a depth of 2 cm. from the external surface of the mastoid process. Hence, no fear need be entertained of its injury in this part, as it is rarely necessary to penetrate the process to that extent in mastoiditis. But the importance of the anatomical relation of the upper part of the facial nerve (as shown in Plates XXXVI to XXXIX) cannot be too strongly emphasized, as its position is such and its protection so slight that in simple operations on the drum or on the contents of the middle ear, or the faulty direction of the chisel in opening the mastoid antrum, the canal may be opened and the nerve injured (abraded, crushed, incised, or severed), thus producing most disagreeable after-effects. The stapes is seen once more lodged in the fenestrum ovale directly below the course of the nerve, but devoid of its muscle on account of removal of its casing of bone posteriorly.

The aditus ad antrum (indicated by arrow in Plate XXXVIII) or passage leading from the upper part (attic) of the tympanum to the antrum, along which the infection of a middle ear disease so often travels into the antrum, can be shown by removing a sufficient amount of bone from the upper and posterior walls of the bony meatus (Plate XXXIX). (This is one of the steps in the Stacke-Schwartze "radical operation.") When this is done the plate of bone forming the roof of the tympanic cavity (called the tegmen tympani) is seen; that portion of bone forming the roof of the antrum is called tegmen antri. The tegmen is very thin (½ to 2 mm.) in most skulls and at times incomplete, and can easily be eroded by the acrid discharge of a middle ear disease. This complication often leads to the formation of an extradural abscess of the middle fossa of the skull or to inflammation of its dural lining, which in time may lead to intradural or cerebral abscesses or to inflammation of the entire arachnoid or pia mater.

With the exposure as described, all the necrosed or diseased bone can be removed, which in itself is often sufficient to check an inflammation of the meninges or brain which has been caused by the necrosis.

An extradural abscess can be drained through the opening made in the tegmen, while a deep-seated one could be more easily reached through the opening in the squamous plate, as will be mentioned farther on (Plates XXXVIII and XXXIX).

On removal of the outer wall of the aditus, as mentioned, the projection formed by the horizontal semicircular canal is seen forming a part of the floor and inner wall of the aditus (Plate XXXIX). It will be readily understood how easily the canal can be opened if on exposing the antrum the chisel is directed too far forward or downward at a depth greater than 1½ cm.

On dislodging the facial nerve from its groove, the inner wall of the aquæductus Fallopii is shown extending from the upper anterior angle of the tympanum backward directly below the horizontal semicircular canal, with the fenestrum ovale beneath it; it then bends downward, with the fenestrum rotundum in front of it, and reaches the stylomastoid foramen at a depth of about 1½ cm. from the outer surface of the mastoid process.

On removal of the tympanic plate the floor of the tympanic cavity is seen to consist of bone varying in thickness from ¼ to ½ cm. Frequently this helps to form the outer wall of the jugular fossa, and where necrosis of the bone or inflammation of the communicating veins in the bone has taken place, an inflammation or thrombosis of the bulbar portion of the jugular vein, which is contained in the fossa, results.

Continuing with the dissection of the mastoid process, we find that on removing the ledge between the upper and lower posterior windows (as shown in Plate XXXVII) and making them continuous, a longer stretch of the descending limb of the sigmoid flexure of the lateral sinus can be exposed, and its walls more readily incised, if it is necessary to inspect its interior or to determine its contents. By inspecting its interior you can determine if an adhering thrombus exists which does not clog the entire lumen. Incomplete thrombi are more frequent where the sinus enters the jugular vein in a more or less straight line, while if they join at an acute angle the thrombus is more often complete. A coating or granulations on the outer side of the sinus, or necrotic areas in its wall, make the presence of a thrombus probable. If no clot is present in such a case, the opening must be packed with gauze and equable pressure made, by means of a gradu-

ated conical compress, to control the hemorrhage. If the inner wall is to be inspected, the hemorrhage must be controlled by packing or compressing the sinus at both ends. If a clot is found, this must be removed and the ensuing hemorrhage controlled as just mentioned. If the entire removal of the clot is not successful, an extended incision must be made above or below or in both directions, according to the extension of the clot, so that complete patency of its lumen is established and the entire sinus can be inspected for possible necrosis of its wall.

The entire course of the sinus can be exposed above by an incision commencing at the upper posterior quadrant in a direction upward and backward and then gradually downward until it reaches the external occipital protuberance, which corresponds on the inside of the skull to the torcular Herophili (Plate XXXVII). The bone covering it can be removed by means of a chisel, circular saw, or drill, and the dural covering incised along its entire course, if this should be found necessary in order to remove the clot or infected matter filling the canal, or to excise the wall itself if found necrotic (Plate XXXVIII).

About 1 cm. above the posterior window the slit leading to the superior petrosal sinus can be seen. Posteriorly the opening to the sinus of the other side is visible, and somewhat in front and above this the longitudinal sinus has its termination. Along the entire course of the lateral sinus, slits representing the entrance of cerebral veins can be seen. Frequently fibrous bands are also found stretching across the lumen and forming supports to maintain the patency of the canal against the pressure exerted by the weight of the brain.

Below and in front, corresponding to the lower posterior window, the sinus will be seen to dip in toward the jugular fossa, forming the lower limb of the sigmoid flexure.

If the symptoms and physical signs of the case make probable the presence of an extradural, intradural, or cerebral abscess, especially of the temporal lobe, which occurs more frequently, or the presence of fluid in the ventricles, a puncture of the brain in various directions can be made through a trephine opening in the squamous portion of the temporal bone. This can be readily exposed on retracting the temporal muscle upward after removal of its fascia (as shown in Plates XXXVII and XXXVIII). On removing the button of bone, a branch of the middle meningeal artery is frequently seen traversing the space. A long aspirating needle or narrow-bladed knife can be passed into the brain in various directions until the presence or ab-

sence of pus in the brain or excessive accumulation of cerebrospinal fluid in the ventricles is determined and located. If pus is found and the trephine opening is not of sufficient size to afford proper drainage, the temporal muscle can be still further detached and all the soft parts be retracted upward and forward so that the opening can be enlarged in various directions.

If the diagnosis of abscess is positive beforehand, and the cerebral cavity is to be opened in combination with the radical ear operation, a quadrilateral osteoplastic flap is made of the squamous portion of the temporal bone and turned forward as mentioned farther on.

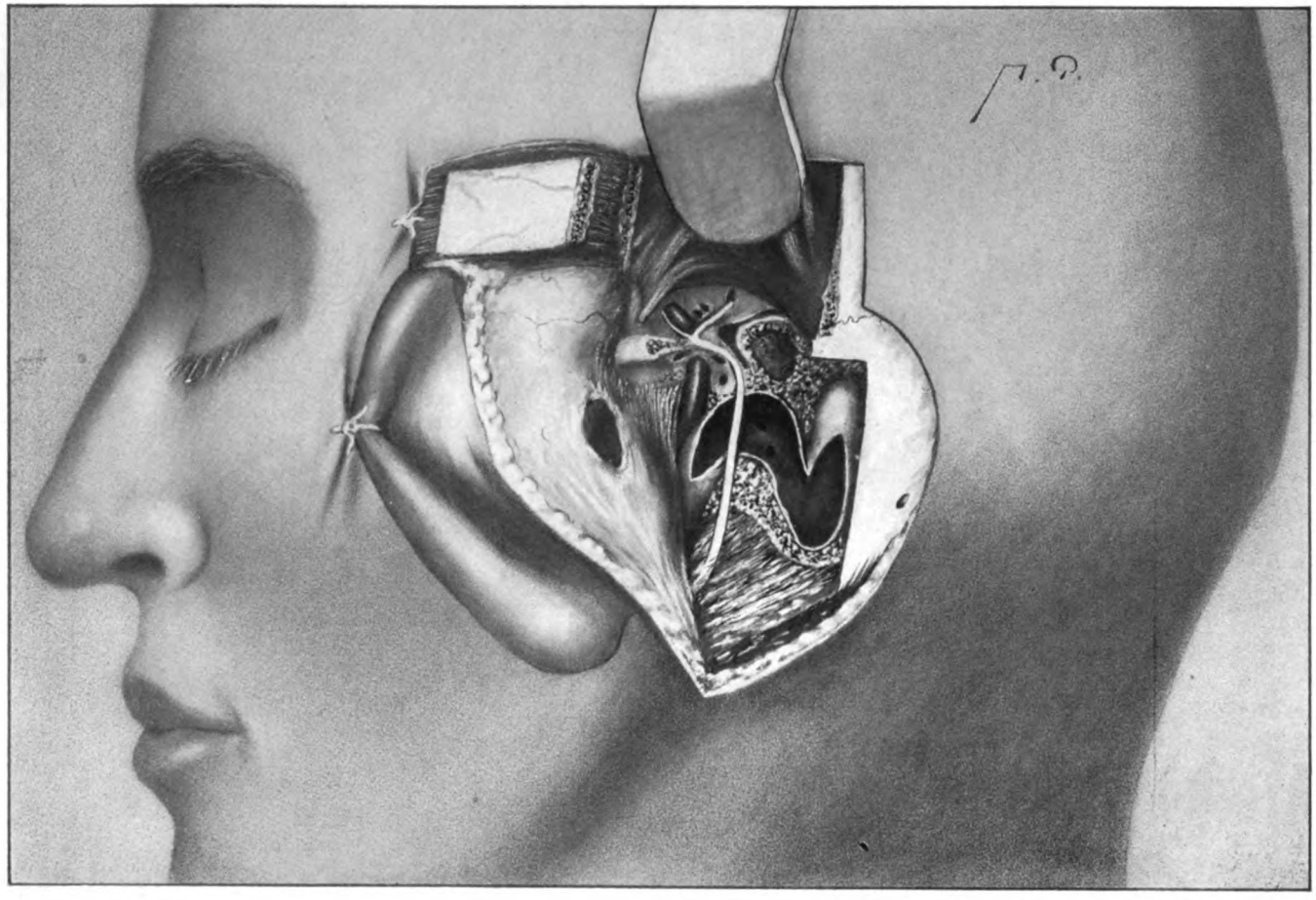
If on incising the lateral sinus in the upper posterior window (as shown in Plate XXXIX) a suspected sinus affection is not found to exist, but the train of symptoms points to the presence of a serious complication in this region, the dura of the cerebral or cerebellar lobes can be exposed by a single or double "trap-door" incision, the course of the lateral sinus serving as a median line from which the osteoplastic flaps can be cut above and below. The incision in the dura mater should be made on three sides only, and should leave a sufficient margin to which the flap can be sewed when replaced subsequently.

Through this exposure the occipital convolutions of the cerebrum, the entire half of the tentorium cerebelli, and the posterior fossa of the skull, with its cerebellum, can be inspected, and extradural, intradural, or brain abscesses can be incised and drained. A simple and tolerably accurate method of locating the horizontal limb of the lateral sinus, without the aid of the mastoid quadrants, is Chipault's method, which consists in taking a point 95 per cent. of the distance between the nasion and inion and joining it by a straight line with the retroorbital tubercle. The posterior half represents the course of the horizontal limb of the sinus (see sketch under technic, below).

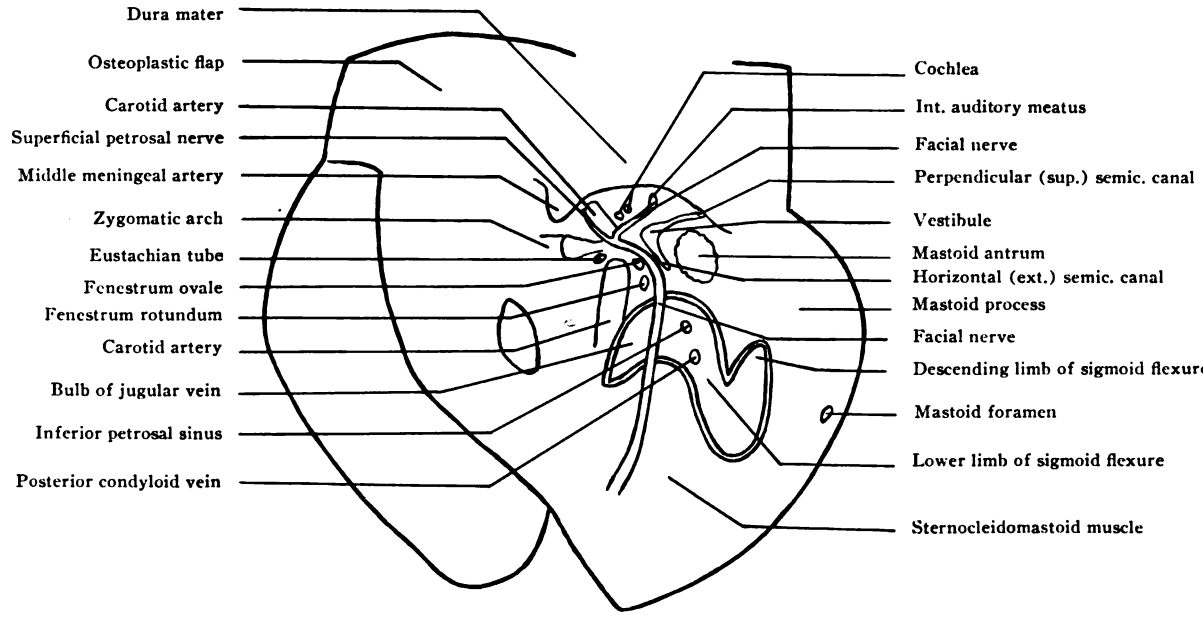
To afford a sufficient exposure for a very deep dissection of the petrous portion of the temporal bone, it is necessary to remove a plate of bone from above the ear, preferably quadrilateral in shape, about 4 cm. long and 3 cm. wide, to include the portion of the squamous plate lying over the posterior half of the zygomatic arch, and reaching back as far as the middle of the mastoid process. The flap, containing skin, muscle, and bone, and nourished by a branch of the temporal artery, is turned forward (Plate XL).

By retracting the dura from the upper surface of the petrous bone, resistance will be met with in front, where the middle meningeal artery emerges from the foramen spinosum. At a depth of about 3 cm. from the exterior

PLATE XL



Deep dissection of temporal bone, with osteoplastic flap of squamous plate, exposing dura mater, carotid artery, entire course of facial nerve in temporal bone, giving off the petrosal nerve at its bend above the middle ear; turns of the cochlea between the facial nerve and carotid artery above, the vestibule with superior and external semicircular canals, and antrum, posteriorly. The remaining portion of inner wall of middle ear shows opening of Eustachian tube in front and fenestra ovale and rotundum behind. Below these the sigmoid flexure of the lateral sinus is seen with the openings of the posterior condyloid vein and inferior petrosal sinus.


Dura mater
Osteoplastic flap
Carotid artery
Superficial petrosal nerve
Middle meningeal artery
Zygomatic arch
Eustachian tube
Fenestrum ovale
Fenestrum rotundum
Carotid artery
Bulb of jugular vein
Inferior petrosal sinus
Posterior condyloid vein
Cochlea
Int. auditory meatus
Facial nerve
Perpendicular (sup.) semic. canal
Vestibule
Mastoid antrum
Horizontal (ext.) semic. canal
Mastoid process
Facial nerve
Descending limb of sigmoid flexure
Mastoid foramen
Lower limb of sigmoid flexure
Sternocleidomastoid muscle

of the skull the carotid artery can be exposed on removal of its bony canal from above. The cochlea will be found situated in the angle formed by the artery as it bends inward and forward from below, while the Eustachian tube, with its gallery containing the tensor tympani muscle, hugs it anteriorly. The opening of the Eustachian tube in the upper anterior angle of the middle ear is directly in front and external to the ascending limb of the artery. In cases where but a thin layer of bone covers the artery, or where the bone is entirely absent in this situation, the artery can be seen pulsating on examining the middle ear, and its puncture by a paracentesis needle, carried too deeply, is possible. Here, too, necrosis of the inner wall of the tympanic cavity, forming the bony canal of the artery, can produce a destructive process in the wall of the vessel and cause fatal hemorrhage if not ligated below in time. The artery is at a depth of about 2 cm. from the auditory process, and has the jugular vein directly behind it and somewhat to its outer side. In all the previous dissections the facial nerve has been exposed only from the anterior superior angle of the tympanum. If we follow the course of the nerve in the aquæductus Fallopii as it emerges from the internal auditory meatus and passes forward between the cochlea and vestibule, it forms an angle of 45° with the long axis of the skull (Plates XL and XLIII). As it enters the middle ear it turns outward and backward, forming an elbow from the point of which the superficial petrosal nerve is given off. The latter passes inward and forward through the hiatus Fallopii along the upper surface of the petrous bone until it reaches the middle lacerated foramen.

The base of the cochlea is formed by the anterior wall of the internal auditory meatus; its apex juts against the Eustachian tube. To its inner side is the carotid canal; to its outer the aquæductus Fallopii, with the facial nerve above and the vestibule below.

The vestibule is seen at the outer side of the facial canal with the horizontal semicircular canal coming from it externally, and the perpendicular semicircular canal superiorly.

The exposure of the sigmoid flexure of the lateral sinus has been brought about by the removal of almost the entire mastoid process (Plate XL). In this procedure injury to the facial nerve must be avoided. This nerve emerges from the stylomastoid foramen, at the depth of about 1½ cm. from the anterior border of the process, and when located the nerve should be gently drawn forward, as the jugular vein will be found ½ cm. to its inner side. The nerves accompanying the sinus through the posterior lacerated foramen

are covered by it so that they need not be considered. The foramen magnum lies 1½ cm. to its inner side and posteriorly. When the sinus is opened, slits of the inferior petrosal and occipital sinuses and the condyloid vein can be seen where these vessels enter the jugular vein. The jugular fossa, which contains the bulb of the vein, varies in shape in different skulls and on both sides of the same skull. At times it is vaulted and smooth and approximates the floor of the middle meatus, but it may be low, contracted, and traversed with irregular ridges. The former condition is considered a predisposing cause in thrombosis of the bulb of the jugular vein on account of the more intimate relation of this part with the middle ear; and the same is also claimed, on account of the more tortuous course the blood stream is subjected to. Infectious material might pass along the entire route of the sinus without producing any harm, but at the jugular fossa the flow of venous blood is checked, producing currents (whirlpool) which favor the formation of a thrombus, on account of the greater liability to injury and infection which the wall of the vein is subjected to.

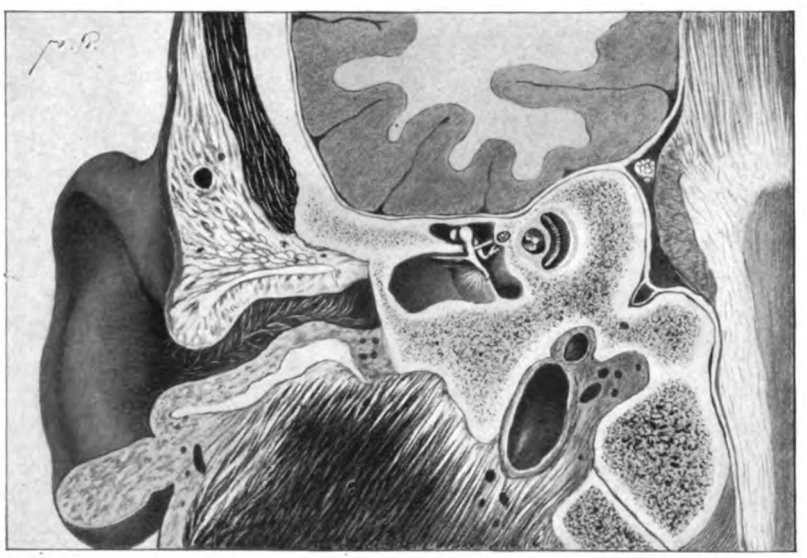
If the bulb of the vein alone is involved, the jugular should be ligated before the sinus and bulb are incised; but if the infection has gone farther, and a cord-like strand on the side of the neck indicates an extensive thrombus of the vein, ligation should not be performed.

To demonstrate the intimate relation between the ear and the cerebral cavity, a transverse section of the head through the center of the middle ear has been made (Plate XLI). The external auditory canal is seen slanting upward and inward, its outer half lined with short hairs directed outward. The external meatus is separated from the middle ear above by a plate of bone which forms the outer wall of the attic, while below is the tympanic membrane, with the manubrium and processus brevis of the malleus attached to it. The roof of the tympanum has a thin plate of bone, the tegmen tympani, separating it from the cerebral cavity.

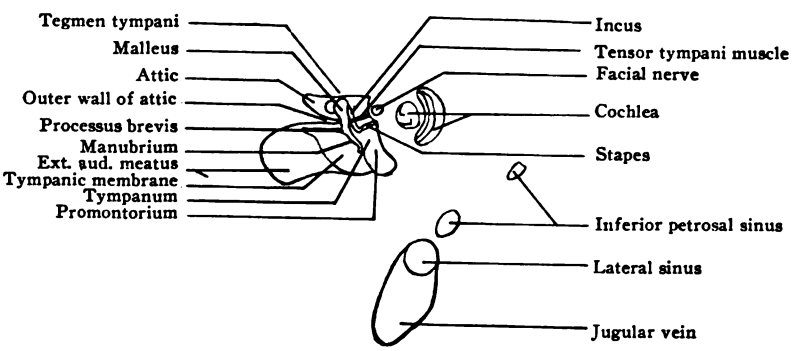
A section of this kind demonstrates the intimate relation between the two parts and shows how readily an erosion or a fissure in the partition may lead to serious involvement of the brain and its covering when the middle ear is inflamed.

On the inner wall of the tympanic cavity can be seen, from above downward, first, the projection made by the aquæductus Fallopii with its facial nerve; underneath this the tendon of the tensor tympani muscle emerging from the upper part of the Eustachian tube. Directly behind it and on the same level is the fenestrum ovale, containing the stapes. From here on down-

PLATE XLI



Cross-section of right side of head, showing external meatus, separated from middle ear by outer wall of atticus above and tympanic membrane below. In the middle ear are seen the tegmen tympani, the ossicles, the tensor tympani muscle, and projections of the aquæductus Fallopii, with facial nerve above and first turn of cochlea below. Deep in the bone the cochlea. Below, the bulb of the jugular vein.


Tegmen tympani
Malleus
Attic
Outer wall of attic
Processus brevis
Manubrium
Ext. aud. meatus
Tympanic membrane
Tympanum
Promontorium
Incus
Tensor tympani muscle
Facial nerve
Cochlea
Stapes
Inferior petrosal sinus
Lateral sinus
Jugular vein

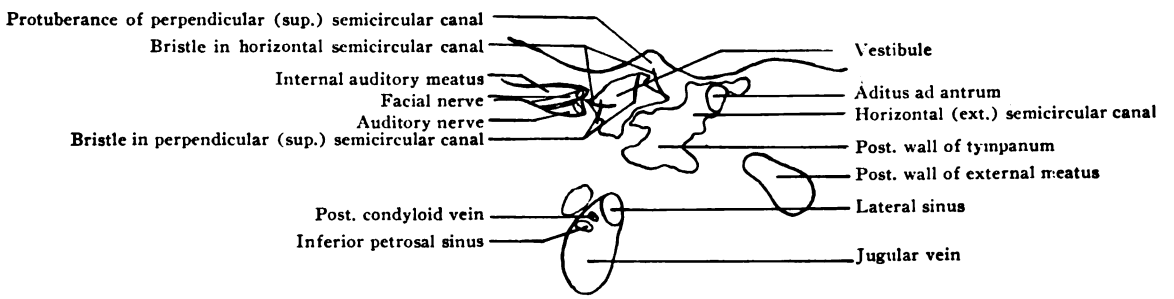

Protuberance of perpendicular (sup.) semicircular canal
Bristle in horizontal semicircular canal
Internal auditory meatus
Facial nerve
Auditory nerve
Bristle in perpendicular (sup.) semicircular canal
Post. condyloid vein
Inferior petrosal sinus
Vestibule
Aditus ad antrum
Horizontal (ext.) semicircular canal
Post. wall of tympanum
Post. wall of external meatus
Lateral sinus
Jugular vein

PLATE XLII

Cross-section of left side of head, 1 cm. behind previous section. A small portion of the posterior wall of external meatus is seen. Internal to this, the tegmen, aditus ad antrum, projections of external semicircular canal and posterior wall of middle ear. The vestibule shows bristles coming from the superior and external semicircular canal. The internal meatus contains the facial and auditory nerves. Below is seen the jugular vein with openings of the posterior condyloid vein and inferior petrosal sinus.

ward the promontorium, representing the beginning of the cochlea, bulges outward, forming a recess with the floor of the meatus. The floor consists of a varied thickness of bone and occasionally communicates with the jugular fossa through fissures or small lymph channels.

The cavity of the tympanum contains the ossicles. Of these the malleus is anterior, with its head in the attic, the tendon of the tensor tympani muscle attached to its neck, and the suspensory ligament extending from the tegmen to its head. Its short process projects outward, throwing the upper part of the membrane into folds, and the manubrium extends downward, with its tip turned outward, attached to the midpoint of the tympanic membrane. The incus is located posterior to the malleus, with its body in the attic, its short process in the aditus, and its long process projecting downward and articulating with the head of the stapes. The stapes is lodged in the fenestrum ovale, with the stapedius muscle attached to its neck posteriorly, and lies horizontally and at right angles both to the malleus and incus.

Internal to the middle ear and set in the most compact part of the petrous bone are the spiral turns of the cochlea, with the apex pointing out and forward and the base butting against the wall of the internal auditory meatus.

Below the bony framework surrounding the ear and lying somewhat to the inner side of the middle ear is the bulb of the jugular vein, in the jugular fossa.

A transverse section of the head, about 1 cm. behind the one just described (Plate XLII), shows only a small portion of the posterior wall of the external meatus, and parts of the middle ear and inner meatus corresponding to that level. Above, a thin plate of bone is seen separating the cerebral cavity from the aditus ad antrum. The aditus, shaped like an inverted pyramid, has the protrusion of the horizontal semicircular canal forming a part of its floor and inner wall. Below this is seen the posterior wall of the middle ear proper, made up of irregular, open bony cells covered with a delicate mucous membrane, which lines the tympanum and communicating cavities. Internal to these parts can be seen the interior of the vestibule, with the openings of the semicircular canals on its outer side. Anteriorly, the anterior ends of the superior or vertical and the external or horizontal canals have a common opening, while posteriorly the posterior end of the superior and the upper end of the posterior canals have a common opening. The openings of a horizontal canal lie on the same plane, while those of the posterior canal lie one above and the other below the posterior opening of the horizontal canal (See also Plate XLIV).

The exterior of the superior or vertical semicircular canal forms a slight protuberance on the upper surface of the petrous bone corresponding to its course, from in front and externally, back and internally.

Internal to the vestibule is the internal auditory meatus containing the facial and auditory nerves; the facial above, directed toward the aquæductus Fallopii, and the auditory below, about to enter the vestibule and cochlea, the direction now considered being from the brain outward.

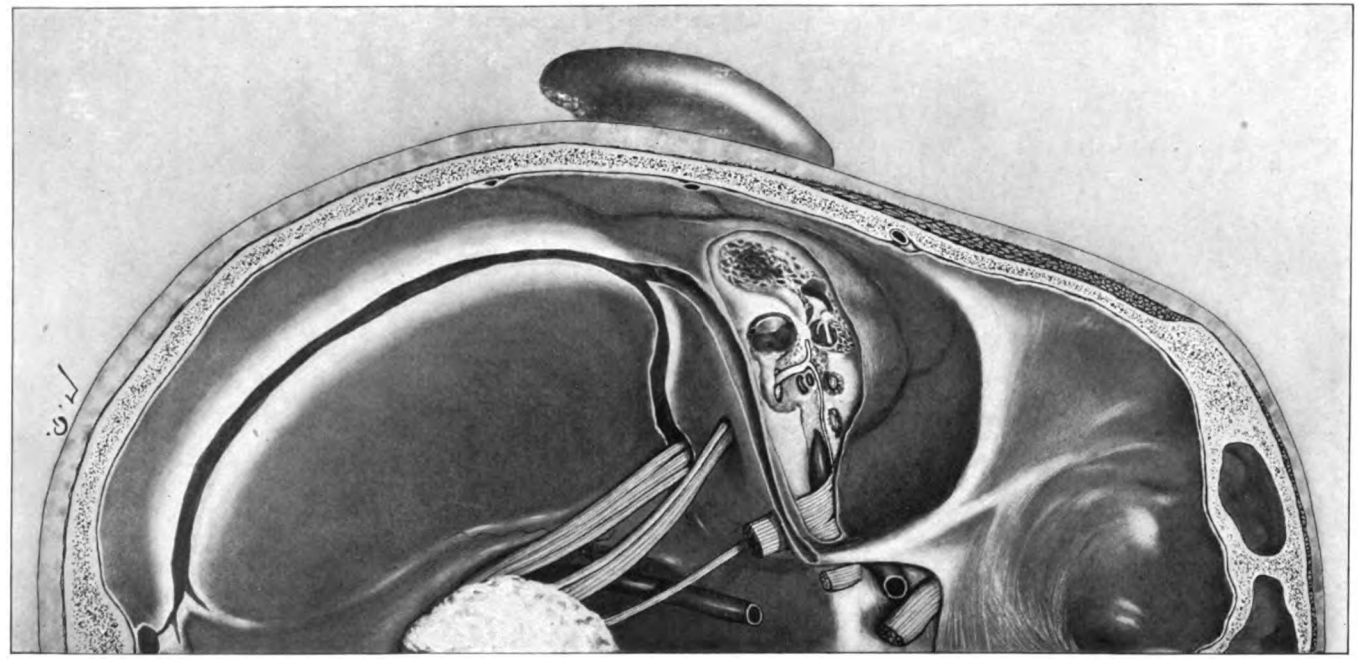
The bulb of the jugular vein is seen in the fossa, and several slits indicate the entrance of emissary veins.

On inspecting the middle and posterior fossa of the skull, when the brain has been raised from its bed, and removing the dura mater over the petrous bone in the middle fossa, the following structures can be exposed by chiseling the bone (Plate XLIII): Externally, the mastoid antrum; in front of it, and coming from the middle ear, the aditus ad antrum. The horizontal semicircular canal is seen helping to form the inner wall and floor of this passage. The middle ear is anterior and internal to the antrum, and presents the malleus and incus in the attic and the tympanic membrane deep down, forming its outer wall. The tensor tympani muscle is seen in its groove in the upper part of the Eustachian tube, passing outward and backward, and becoming inserted into the neck of the malleus. The facial nerve is seen as it disappears at the upper anterior angle of the tympanum, forming an elbow from the angle of which the superior petrosal nerve is given off. Posterior to this point it lies between the cochlea, which is on its inner, and the vestibule, which is on its outer side. In the internal auditory meatus it lies above the auditory nerve, and in the posterior fossa to its outer side.

The vestibule shows the groove of the superior semicircular canal and the openings of the other two canals. The cochlea lies in the back part of an angular recess formed by the bend in the carotid canal as it ascends from the base of the skull, and has the tympanic cavity and aquæductus Fallopii, with the facial nerve to its outer side. The Eustachian tube is in front, the internal auditory meatus behind, and the compact bone over the carotid canal to its inner side.

The carotid canal has the general direction of the petrous bone inward and forward, with the Eustachian tube immediately in front of it, the superficial petrosal nerve coursing over it as it passes from the hiatus Fallopii to the middle lacerated foramen and compact bone behind it. As it ascends from the base of the skull it is directly internal to the inner wall of the middle ear. As the canal passes inward toward the middle lacerated foramen, the Gas-

PLATE XLIII



The dura mater of the middle fossa of skull is cut away, showing a dissection of the temporal bone. From without inward are seen the mastoid antrum behind, the tympanic cavity, with ossicles in front, and the aditus ad antrum between. The vestibule shows the openings of the semicircular canals. The facial nerve has the superior petrosal nerve coming from its bend and passing inward. In front of the nerve the tensor tympani muscle is seen in the Eustachian tube; behind it, the cochlea and internal auditory meatus. Internal to these the carotid canal, the carotid artery, and the Gasserian ganglion. Posteriorly the lateral and superior petrosal sinuses have been slit open. The seventh and eighth nerves are seen entering the internal auditory meatus; the ninth, tenth, and eleventh, the jugular fossa.

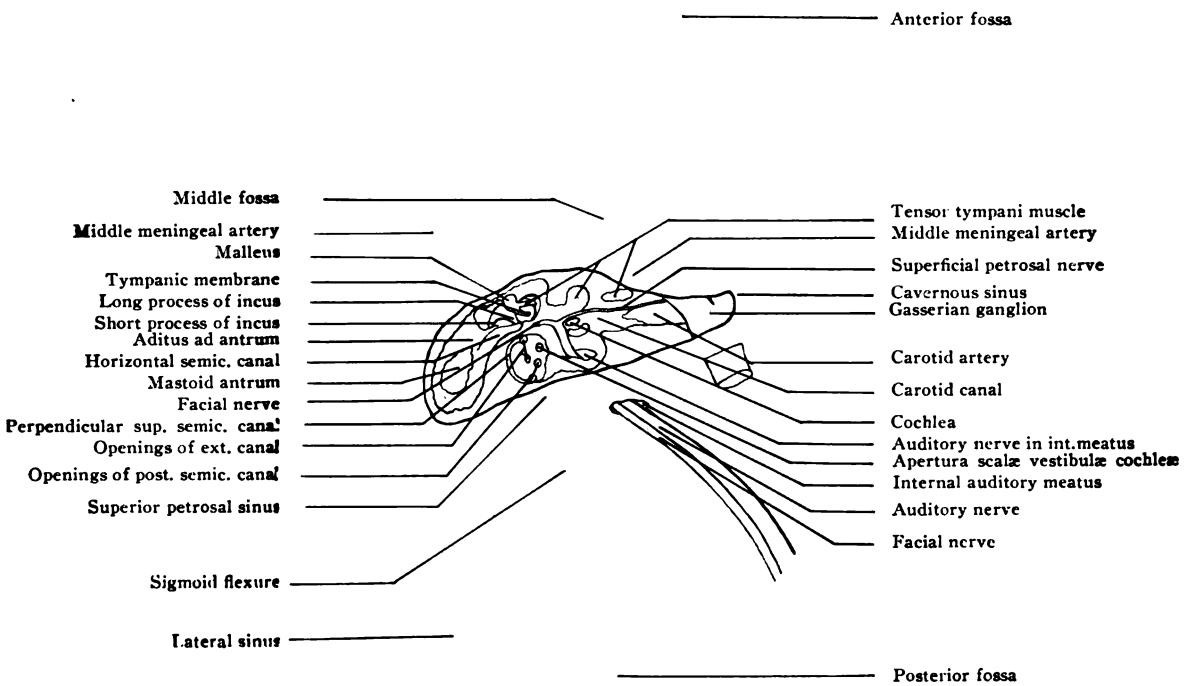
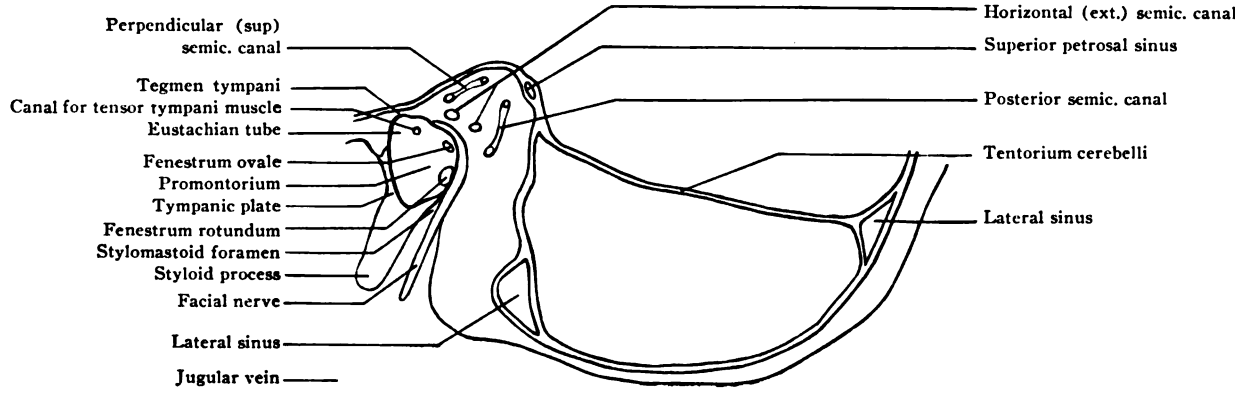

Anterior fossa
Middle fossa
Middle meningeal artery
Malleus
Tympanic membrane
Long process of incus
Short process of incus
Aditus ad antrum
Horizontal semic. canal
Mastoid antrum
Facial nerve
Perpendicular sup. semic. canal
Openings of ext. canal
Openings of post. semic. canal
Superior petrosal sinus
Sigmoid flexure
Lateral sinus
Tensor tympani muscle
Middle meningeal artery
Superficial petrosal nerve
Cavernous sinus
Gasserian ganglion
Carotid artery
Carotid canal
Cochlea
Auditory nerve in int.meatus
Apertura scalæ vestibulæ cochleæ
Internal auditory meatus
Auditory nerve
Facial nerve
Posterior fossa
Occipital sinus
Right lateral sinus
Longitudinal sinus

PLATE XLIV

Anterior-posterior section through middle ear. On inner wall of tympanic cavity are seen the opening in the processus cochleariformis and Eustachian tube in front; facial nerve behind, and fenestra ovale and rotundum, with promontorium below. Above the tympanum are seen the superior, external, and posterior semicircular canals and superior petrosal sinus. Below are the styloid process, stylomastoid foramen and jugular vein. Also cerebrum, tentorium cerebelli, cerebellum and lateral sinus.


Perpendicular (sup) semic. canal
Tegmen tympani
Canal for tensor tympani muscle
Eustachian tube
Fenestrum ovale
Promontorium
Tympanic plate
Fenestrum rotundum
Stylomastoid foramen
Styloid process
Facial nerve
Lateral sinus
Jugular vein
Horizontal (ext.) semic. canal
Superior petrosal sinus
Posterior semic. canal
Tentorium cerebelli
Lateral sinus

serian ganglion lies over it, in a depression at the inner end of the superior surface of the petrous bone.

The middle meningeal artery can be seen through the dura mater as it emerges from the foramen spinosum, and sends its anterior and posterior branches outward and upward, grooving the skull in its course. The superior petrosal sinus is seen running along the superior posterior border of the petrous bone, joining the lateral with the cavernous sinus.

The lateral sinus extends from the torcular Herophili behind to the jugular foramen in front. At the torcular it communicates with the lateral sinus of the other side, the longitudinal sinus above, and the occipital below. The part which descends from the horizontal limb to the jugular foramen is known as the sigmoid flexure of the lateral sinus. It forms an elbow with the horizontal limb, and passes downward and inward in the deeply grooved bone until it reaches the posterior lacerated foramen, where it is joined by the inferior petrosal sinus and the posterior condyloid vein to form the internal jugular vein. It is accompanied by the ninth, tenth, and eleventh nerves, which have separate sheaths of dura mater.

If a vertical anteroposterior section of the head is made to pass directly through the tympanic cavity (as seen in Plate XLIV) the following points of interest can be shown: Between the tympanic and cerebral cavities the tegmen tympani, on the inner wall of the middle ear which is covered by delicate mucous membrane, the orifice of the Eustachian tube and the canal for the tensor tympani muscle (processus cochleariformis); the latter has an orifice at its posterior end, and transmits the tendon of the tensor tympani muscle; behind this the aquæductus Fallopii, with the facial nerve passing back and down, around the fenestrum ovale; underneath this the promontorium, with the fenestrum rotundum. Projecting from the floor downward is the styloid process. Below this is a section of the jugular vein.

Above and posterior to the middle ear is the body of the petrous bone traversed by the semicircular canals. The openings of the horizontal or external one are above and parallel to the facial nerve; the vertical or superior passes from in front upward and posteriorly; the posterior canal is situated behind, with one opening above and the other below the posterior opening of the horizontal, as mentioned previously.

At the upper posterior border of the petrous bone is the superior petrosal sinus. A part of the sigmoid flexure of the lateral sinus is seen at a point where the occipital meets the petrous bone. The opening of the lateral sinus is seen behind at a point where the tentorium cerebelli meets the dural lining

of the occipital bone. The tentorium is seen separating cerebral from cerebellar convolutions.

In recapitulating the operative technique mentioned in the foregoing pages five separate procedures may be described:

First, "radical" exposure of the middle ear; second, exposure of the mastoid antrum; third, exposure of the mastoid antrum and cells and lateral sinus ("mastoid quadrants"); fourth, exposure of the temporal lobe of the brain and middle fossa of the skull; fifth, exposure of the occipital lobe of the brain, tentorium cerebelli, cerebellum, and posterior fossa of the skull.

For the "radical" exposure of the middle ear an incision is made ½ to 1 cm. behind the attachment of the auricle extending from above the ear downward to the tip of the mastoid process (Plate XXXIII). Above the temporal ridge, which corresponds in height to the upper wall of the outer meatus (Plate XXXIV), the incision should be through skin and superficial fascia alone, leaving the temporal muscle intact. Below the ridge it should pass directly to the bone. The tissues are dissected forward and the periosteum elevated until the bony meatus is reached. To avoid possible necrosis of the tympanic plate the soft parts of the posterior and upper wall of the soft meatus alone should first be detached with an elevator and then incised by means of a thin-bladed knife near the tympanic membrane and held against the anterior wall with a long, narrow retractor; or, if the tympanic plate is to be chiseled away, the anterior and lower walls can be cut also and the entire funnel of soft tissues drawn out of the bony canal and retracted with the auricle. The tympanic membrane is now cut from its ring of bone and removed with the malleus after the attachment of the tensor tympani muscle has been severed. With a chisel, or preferably a burr drill, the outer wall of the attic, which corresponds to the inner part of the upper wall of the external meatus, is then removed until the roof of the attic is continuous with the upper wall of the external meatus (Plates XXXVI and XXXVII). If this does not give a sufficient exposure the tympanic plate can be chiseled away as far as the styloid process (Plate XXXVIII). After removal of the incus (Plate XXXVII), which should be cautiously done, so as not to dislodge the stapes from the fenestrum ovale, a probe should be passed through the aditus into the antrum, and the bone chiseled or drilled away external to it (Plates XXXVIII and XXXIX). The interior of the cavities are now curetted and smoothed, care being taken not to open the aquæductus Fallopii and horizontal semicircular canal, nor to dislodge the stapes. If the tegmen is necrosed, this should be removed, but puncture of the dura mater should

be avoided. An extradural, intradural, or cerebral abscess can be located or drained through this aperture, but a trephine opening through the squamous plate of the temporal bone, after the temporal muscle has been detached and drawn upward, is better for this purpose (Plate XXXVIII). The latter will also suffice for aspirating the lateral ventricles for excessive accumulation of cerebrospinal fluid. If a deep dissection of the temporal bone is necessary, especially if the upper surface of the petrous bone is to be exposed, or if an abscess is not drained sufficiently through the trephine opening just mentioned, a quadrilateral osteoplastic flap, 3 cm. wide and 4 cm. long, with its base anteriorly, should be made to include the portion of squamous bone lying over the posterior half of the zygomatic arch, and reaching back as far as the middle of the mastoid process (Plate XL). If the upper portion of the petrous bone is to be chiseled, the dura mater should be elevated gently and the brain retracted with a broad, blunt retractor. More room can be obtained by incising the dura and permitting some cerebrospinal fluid to escape. This should not be done if pus is present or if the brain or its coverings have not already been attacked. After the tissues have been replaced to their original position and sutured, an opening is left sufficiently large for drainage, and the wound packed with gauze until epidermization of the exposed parts is complete.

To expose the mastoid antrum an incision is made ½ to 1 cm. behind the auricle, extending from a point corresponding in height to the upper wall of the external meatus downward to the tip of the mastoid process (see cross on Plate XXXIII). The tissues are dissected forward and the periosteum elevated until the suprameatic spine can be felt with the finger or an instrument. Keeping below the temporal crest, an opening is made with a chisel or burr drill 1 cm. behind the suprameatic spine. The instrument should be directed forward, inward, and slightly upward, corresponding to the direction of the external meatus to a depth of 1 to 2 cm. When the instrument has penetrated deeper than 1½ cm., care must be taken not to open the horizontal semicircular canal or aquæductus Fallopii. When the antrum has been reached, granulations or irregular bony ridges should be removed by means of a curette, care being taken to avoid piercing the tegmen antri above or the bone behind which separates the antrum from the lateral sinus. If the latter be exposed no harm need necessarily result, but if punctured, the hemorrhage must be controlled by packing the bony wound with a graduated gauze tampon. When the antrum is clean and smooth the parts are replaced and sutured, leaving an opening for drainage. When the cavity is again in a

healthy condition the opening will close by granulation, or a small plastic operation will be required to effect this.

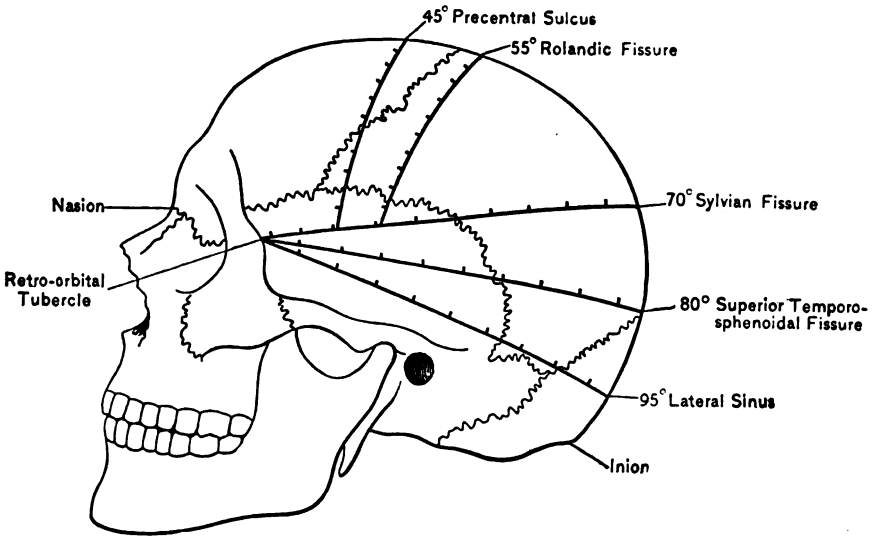
If the lateral sinus is to be exposed with the antrum and mastoid cells, the mastoid process should be divided into four quadrants, as described previously (Plates XXXV to XXXVII). The anterior superior quadrant is opened first with the instrument directed as mentioned in the previous operation, and the antrum cleaned and packed. Next, the two lower quadrants should be opened and evacuated. After packing these to prevent inflammatory discharges from spreading, the upper posterior quadrant should be entered and the lateral sinus exposed. Here the instrument, preferably a burr drill, should be directed straight in. Palpation of the sinus must be performed very carefully, in order not to dislodge adherent or incomplete thrombi. In such a case, aspiration with a hypodermic syringe might show blood and lead to an erroneous diagnosis, so that an exploratory incision is safer. For this purpose the lower posterior quadrant should be drilled sufficiently deep to expose the sinus below, and the ledge between the upper and the lower quadrant should be removed in order to make them continuous.

To expose the entire sigmoid flexure of the lateral sinus and the bulb of the jugular vein, the lower portion of the mastoid process must be removed (Plate XL). The facial nerve should be located and exposed to its exit at the stylomastoid foramen, and the spongy bone between it and the sinus chiseled away. Posteriorly the foramen magnum must be avoided. If the thrombus is still confined to the upper portion of the jugular vein, ligation should be performed below this point before the sinus is incised.

If the horizontal limb of the sinus is to be exposed, an incision from the upper posterior quadrant, first upward and backward, and then downward and backward toward the external occipital protuberance, is to be made (Plates XXXVII and XXXVIII). A strip of bone is then removed by means of a chisel, circular saw, or drill, and the sinus incised to the extent of the clot. Hemorrhage is to be controlled with gauze strips or compresses, the former to be introduced directly into the lumen; or, if this is insufficient, compression should be applied to the external surface of the sinus after detaching it from its bony casing. The parts are subsequently replaced and sutured, a sufficient opening being left for drainage.

To expose the occipital lobe of the brain, the cerebellum, or posterior fossa of the skull, a single or double "trap-door" incision is made above and below the lateral sinus (Plate XXXIX). To locate the latter, Chipault's method can be applied. It consists in taking 95 per cent. of the distance between the

PLATE XLV



Chipault's method of brain localization.

nasion and inion, and joining this point with the retroorbital tubercle. The posterior half of the line represents the horizontal limb of the lateral sinus.

The incision through the bone is made by means of a circular saw, a drill, or a trephine and Gigli's wire saw. The base of the bony flap is to be nicked on either side with the chisel, so that the bone will break off in a straight line when pried open with the elevator. The dura is to be incised in the same direction as the outer flap, a sufficient margin being left if the condition found permits subsequent suturing.

Other points of interest in cranial topography are located by the same method just mentioned (Chipault's), to wit: A point 80 per cent. of the distance between the nasion and inion joined with the retroorbital tubercle represents the course of the parietooccipital fissure. A point 70 per cent. the distance of the same sagittal line joined with the tubercle represents the course of the fissure of Sylvius. If the latter be divided into tenths, and the junction of the third and fourth tenth be joined with the 55 per cent. point on the longitudinal line, the course of the Rolandic fissure is shown; and if the junction of the second and third tenth on the Sylvian line be joined with the 45 per cent., the precentral fissure is indicated. The middle meningeal artery crosses between the second and third tenths of the three primary lines.

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PAUL B. HOEBER, 67-69 EAST 59TH STREET, NEW YORK.